MARCH 1956

PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

BALL-DROP IMPACT TESTING FOR ESTIMATING THE TOUGHNESS OF POLYETHYLENE FILM

A BILL BROTHERS PUBLICATION

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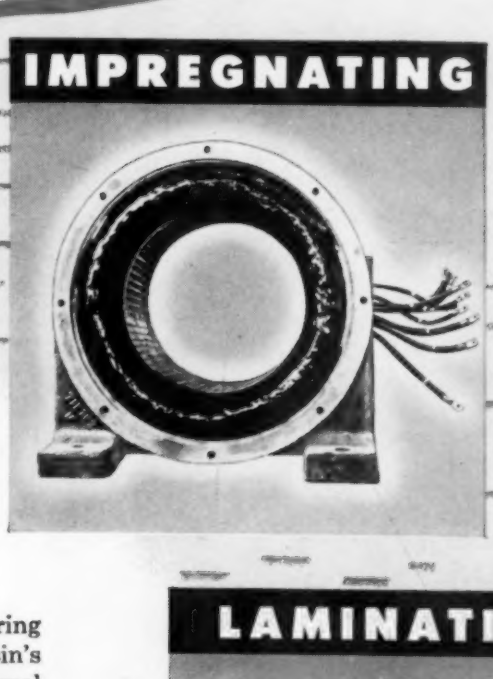

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PLASTICS TECHNOLOGY

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MARCH, 1956

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Letters to the Editor

Additions to Stabilizers Article

Dear Sir:

It would be greatly appreciated if you would show the following three corrections to the article on vinyl stabilizers by Dr. Bruins and myself (Nov. & Dec. 1955):

(1) B Si WL 200, a basic silicate white lead made by Eagle-Picher Co. A powder having a density of 5.1.

(2) Ferro 920, an 100% epoxy resin (equivalent to Epon 864) made by Ferro Chemical Co. A semi-solid having a density of 1.14.

(3) Ferro 931, 50% Epon 863 in high-boiling solvent, made by Ferro Chemical Co. A liquid with a density of 1.06.

Matthew Perry, Chief Chemist
Niemand Bros., Inc.
Long Island City, N. Y.

• • •

Market Price Listing

Dear Sir:

With reference to your offer on page 5 of the January issue, we would very much appreciate it if you would incorporate in your list the current market prices of our Ladcote compounds. These materials are blends of polyethylene wax and other additives, and are in wide use in the paper coating industry.

R. W. Spake, Tech. Sales,
L. A. Dreyfus Co.
Plainfield, New Jersey

(*The Ladcote prices have been added to our listing of current market prices. This letter is printed to remind other suppliers of materials to furnish us with price quotations on their products for inclusion in the market price listing. —Editor*).

• • •

Patent Office Needs Help

Dear Sir:

There is a serious delay in the processing of patent applications in the U. S. Patent Office because the size of the examining staff has not kept pace with the increased number of patent applications filed. This creates uncertainty as to the patent status of new products and processes, and tends to slow down or defer their adoption by industry and their introduction to the public.

This is a matter that affects your subscribers and advertisers. It can handicap the larger corporations, and can be critical for the individual inventor and the small business whose operations revolve around patented products and processes.

Congress has appropriated additional funds for new Patent Examiners, but with the existing demand for engineers and scientists in industry it has been impossible to obtain enough candidates having the necessary technical qualifications. Because this is becoming a matter of national concern, several of the patent law associations have agreed to supplement the work of the Patent Office in recruiting new Examiners.

There are vacancies in the Patent Examining Staff which should be filled promptly this spring, and we are sure that there are technically and scientifically-trained people among your readers who would be interested in these positions.

Henry E. Sharpe, Committee on Public Relations,
New York Patent Law Association
New York, N. Y.

(*This letter is self-explanatory. Readers interested in positions as Patent Examiners should contact the Commissioner of Patents, Washington, D. C.—Editor*).

• • •

"Plastic" Too Generalized a Term

Dear Sir:

The November issue of your fine magazine contains a guest editorial by Harry Kline concerning the public's confusion with plastics. We feel that Mr. Kline's editorial is extremely well done and contains a factor which has affected and continues to affect the entire plastics industry.

I would like to point out that the content of Mr. Kline's editorial apparently has not been recognized as valid by your editors; at least two major papers presented in the January issue are guilty of the use of the word "plastic" without adequate descriptive terms in the title or subtitle.

This is not meant to reflect on the content of the papers, as both Mr. Darling's and Mr. Cutler's papers are very well done.

We do not wholly agree with Mr. Cutler's philosophy when applied to the

aircraft structure; however, the content of his paper is true when the limitations he has placed upon the plastic are taken into consideration.

E. P. Warnken, President
Cincinnati Testing & Research Laboratories,
Cincinnati, Ohio

(Mr. Kline's editorial comments on "plastics" as being too general a term referred to the confusion aroused in the public which is not aware of the wide range of materials and properties involved.

Mr. Darling's paper, "Visco-Mechanical Concept of Plastics Testing," dealt with a concept, rather than a specific plastic material. Except for the data listed in his Table 1 (on methyl methacrylate), the paper applied to all plastics. He states in the text that "a great number of plastic materials, including laminates, moldings, and castings (both thermosetting and thermoplastic), have been evaluated in our laboratory."

Mr. Cutler's paper uses the term "reinforced plastic laminate" in the text, but the data tables in the article show that the materials so designated are polyester-glass laminates.—Editor).

• • •

Information Wanted

Dear Sir:

Please advise whether you know of any plastic material available in sheets approximately four feet by 10 feet by 1/16, 3/32, or 1/8-inch with the following characteristics:

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(2) Non-corrosive.
(3) Strong.
(4) Relatively cheap; up to 20¢ per foot.

A. Roskies
Lion Rubber & Plastics, Ltd.,
Montreal, Que., Canada

(Any helpful suggestions from our readers will be forwarded.—Editor.)

• • •

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address. . .Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request the identities of such "problem" letters will not be divulged.
—The Editor

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NEWS in BRIEF

Research can be credited with building a broad product base on which the plastics industry grew 30% during 1955, according to H. W. Mohrman, research director of Monsanto's plastics division. While only a few fundamentally new plastics have been developed in recent years, the plastics research labs have provided a continual flow of new formulations which have enabled the industry to broaden its product base and win important new markets.

A plastic pipe identification program has been announced jointly by SPI and the National Sanitation Foundation to assure the public of safe, uniform quality for potable water use of pipe bearing the NSF approval seal.

Inconsistency in test methods used by suppliers to report data on their materials prevents a true comparison of plastics on the basis of their properties, says R. A. Rybak, chief engineer of R & K Tool & Die Co. (See guest editorial, pages 166-7). The industry must unify the methods it uses to obtain physical data on plastic materials and, in so doing, develop test methods that will provide more indicative data from the viewpoint of the processors. Mr. Rybak also urges the adoption by the plastics industry of a standard material classification based on a numeral index system.

New Hylene isocyanates plant of Du Pont is now in production at Deepwater Point, N. J. Plant production is rated at 25-million pounds per year. Du Pont will not make any finished products, but will supply the organic isocyanates in types that can be combined with other chemical compounds to form plastics, including rigid and flexible foams, and urethane rubbers.

A license agreement with Phillips to make new types of polyolefin plastics, including polyethylene, has been signed by Pullman, Inc. New facilities will be built by Pullman for this production, which broadens the present base in the plastics field of its subsidiary, M. W. Kellogg Co.

Company expansions in plastics continue unabated. Borg-Warner will build a $10-million plant in Washington, W. Va., to make Cycolac thermoplastic resin, now being produced by the firm's Marbon division. A PVC resin plant with an annual capacity of 30-million pounds is being erected in Pensacola, Fla., by Escambia Bay Chemical. Expanded facilities at its Everett, Mass., plant will provide a 60% increase in Monsanto's phthalic anhydride output. Panelyte Div. is opening a new thermoplastics lab in Richmond, Ind. A substantial addition to its new plant is under way by Resistoflex. By a stock transfer, St. Regis Paper is acquiring Chester Packaging Products, which will operate as a subsidiary. U. S. Industrial Chemical has completed its new half-million dollar pilot plant in Cincinnati, O.

New plastics companies announced during the month included American Sound Corp., formed jointly by Allied Record Mfg. and Bart Mfg. to make tapes, records, and matrices; and Interplastics Corp., a new firm to supply, distribute, and import plastics materials.

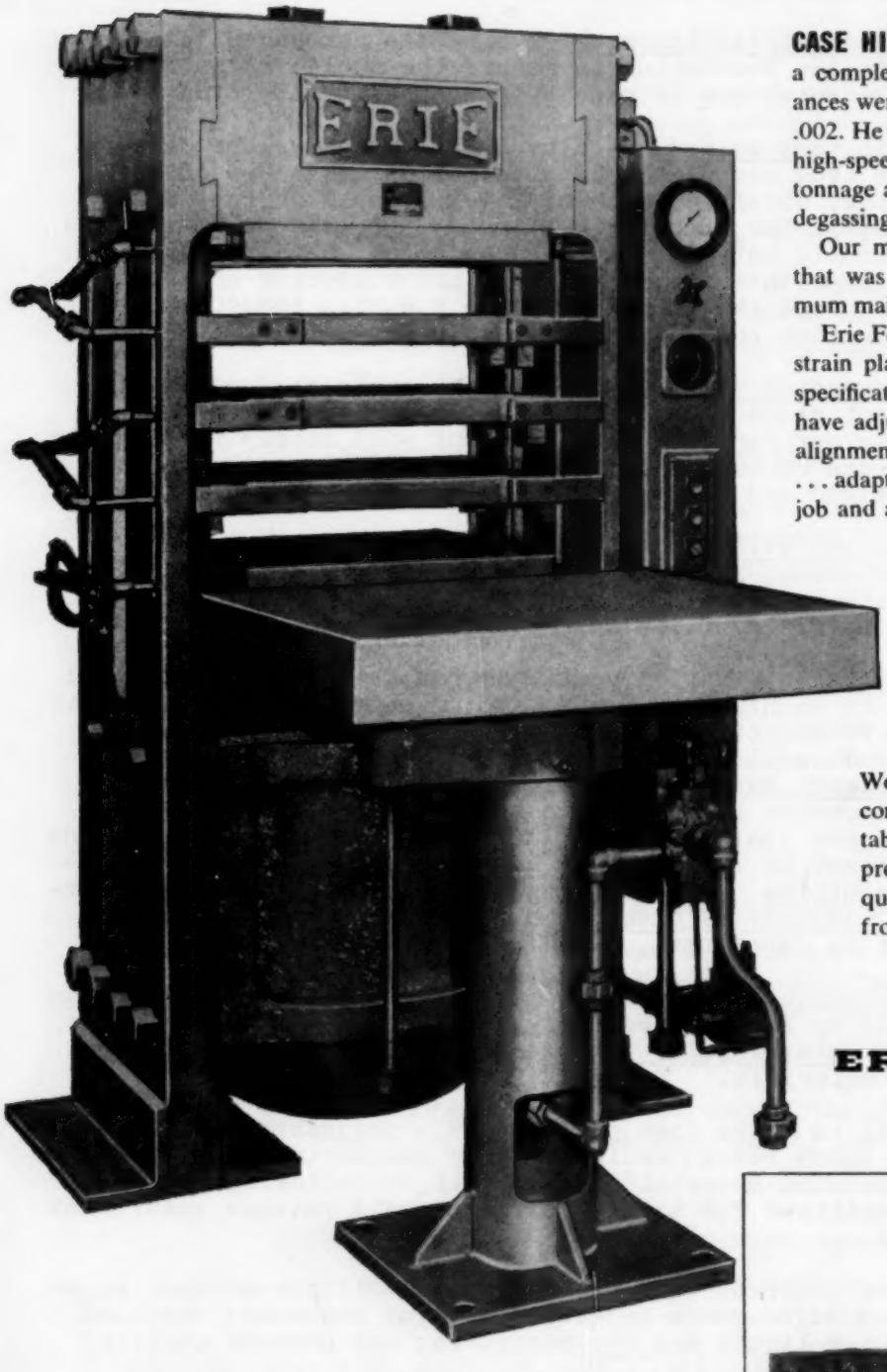
New materials to be noted (see pages 188-9): secondary plasticizer for vinyls; low-viscosity epoxy resin; modified epoxy laminating resin; polyethylene general-purpose molding material; thixotropic, non-flowing epoxy resin; organic cadmium stabilizer for vinyls; silicone mold release agent; and two vinyl spray plastisols.

New equipment of interest (see pages 190-1): multiple-chamber polymerization reactor; 24- and 48/64-ounce injection molding machines; vertical change-can mixer; blender for liquid and dry materials; and process quality control instrument.

New Products worthy of mention (see pages 192-3): reinforced polyester plastic aquaplane; plastic calculating chart; polyethylene film-encased life jackets; polyethylene pipe housings for wire; epoxy cable-splicing compound; porous laminated vinyl shoe insoles; a molded styrene-butadiene-acrylonitrile housing for a radio-phonograph extension speaker.

Erie Press of the Month

COMPRESSION MOLDING PRESS



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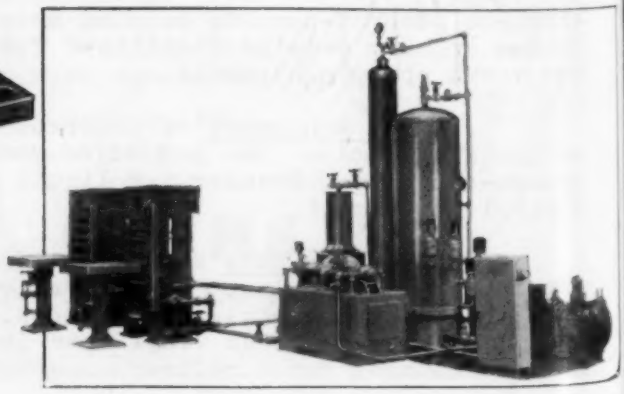

WE BUILT THE HYDRAULIC POWER SYSTEM, TOO!

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"Quote . . . Unquote"

Need for Industrial Leadership

"Nothing is more important in human endeavor, be it the defense of our country or the building of a new industry, than the development of good leaders and teamwork, and you cannot have good teamwork unless you have good leaders.

"We must remember that young people are coming up who are anxious to fill these roles. They will carefully watch their elders, study and work harder than many of us, and think and strive to become what we most want them to become. We have seen clearly that the kind of leadership we require . . . must be based on a high degree of knowledge and imagination. Therefore, we must realize that we have a tremendous responsibility to train and help this new leadership. Let us not tell our young people that the burden of the future will rest on their shoulders, without first clearly understanding that their future burden now rests on us. I know of no field that offers more opportunity to the young man or young woman for leadership in the years ahead than the chemical industry."

Gen. J. E. Hull, (U.S.A., Ret.), Pres. Manufacturing Chemists' Association, Inc., Washington, D. C.

• • •

Appraising Industrial Research

"The lever that moves our industrial world is, of course, the lever of research and technology. It is that force, exercised today by thousands of men in hundreds of laboratories, that gives us our enduring assurance of an ever-brighter future.

"I have spent a good bit of time trying to work out some way of appraising research results quantitatively. It is not an easy job, and perhaps in the end one must simply take technology on faith. I can, however, give you these figures. Over the last 30 years the Du Pont Company has invested in new construction somewhere between $20,000 and $25,000 for each man-year spent by one of our research people in his laboratory. Since it takes about $20,000 of investment to create one job in industry, it might be said that the average research man during his 40-year working life would have created the basis for 40 jobs. And those are not temporary jobs since they represent, by and large, permanent additions to our industrial scene and to our people's prosperity.

"I do not think it is important to know precisely what the developments of the future will be and how they will affect our lives. It is enough to know that they will come, and that the long-term future of this nation is as bright today as it has been at any time in its history."

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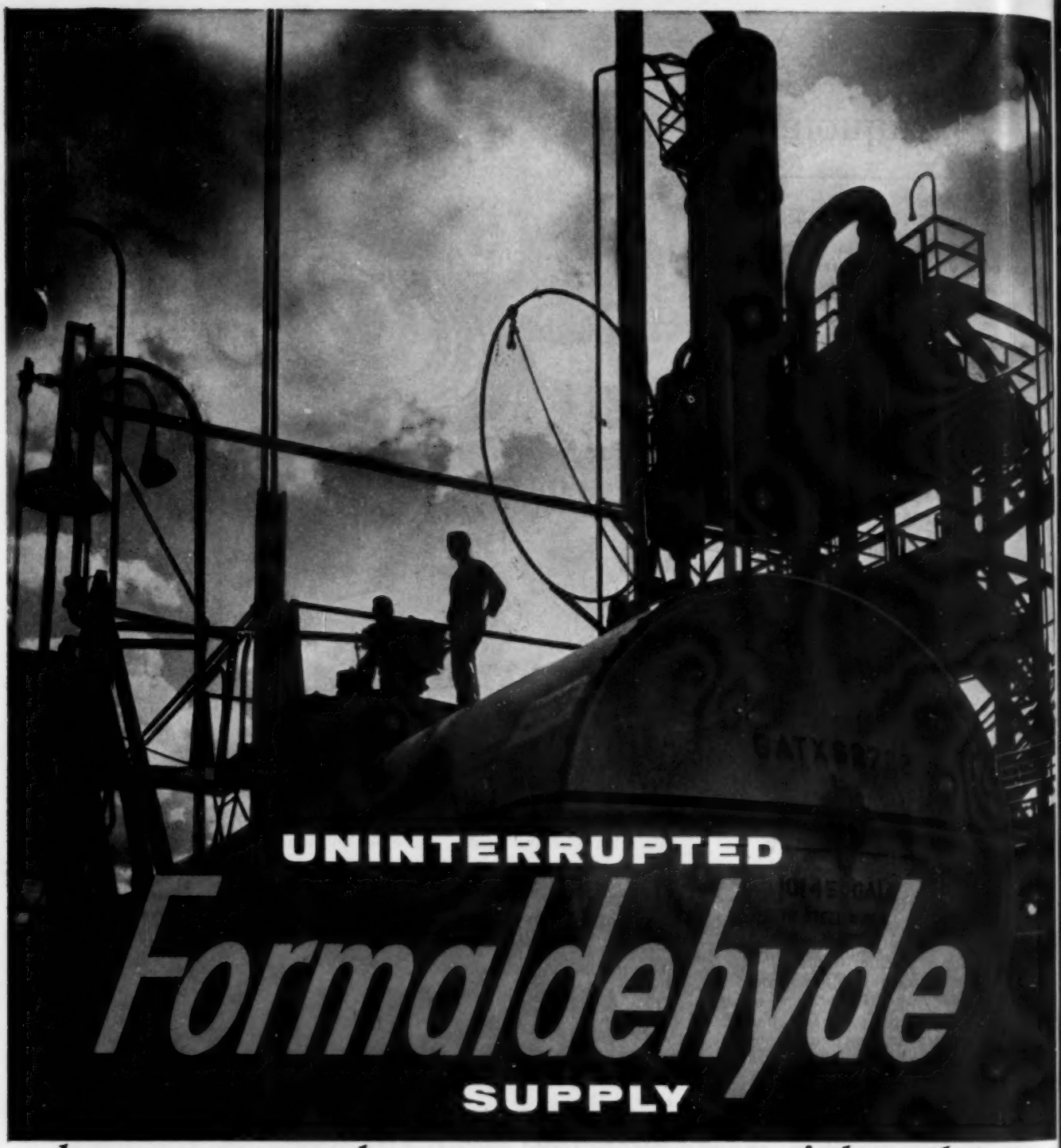

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PLASTICS TECHNOLOGY

MARCH, 1956

EDITORIAL: Do You Have a Secret?

In its evolution, every new industry goes through a period of growth wherein its techniques are classified as arts or secrets. In this period of industrial childhood, technical progress is slow and all developments made are considered to be the developer's secrets.

In this childhood stage, most of the processing companies in that industry spend a good deal of time and effort in guarding their own precious secrets and, conversely, in trying to ascertain the secrets of their competitors. During this period of secrecy, the only technical information made available to all is that gathered by the suppliers of materials and equipment for that industry.

•

As the new industry continues to mature, a more enlightened attitude toward this secret information becomes evident. To a major extent, this new attitude can be traced to the technical men of that industry. With their relatively free interchange of ideas and information at meetings of the industry's professional societies, the technical men soon recognize that many of their company's most cherished secrets are only bits of technology that are being employed quite universally throughout that industry.

This discovery presents the technical men with the difficult task of trying to convince management of the true state of affairs in the growing industry. This period of convincing management is the industry's stage of adolescence—difficult, often painful, and usually lengthy in duration.

The plastics industry is now in adolescence. The technologists recognize that many of their company's most guarded secrets are not really secret at all, but management is not convinced. From our position as a sounding board for the dissemination of technical information on plastics, we are all too aware of the situation.

Time and again, we have been either shown or informed of a specific development by a company which that firm considers to be its secret. While respecting that company's confidence, we cannot help but be painfully aware that this same development has been made by at least one other firm in the field! And each of these companies is zealous in guarding its "secret!"

These unconvinced managements are quite vociferous in asking that we publish detailed articles of the how-to-do-it type on plastics processing, but do not realize the incongruity of their steadfast refusal to write on their own processing developments; these are secret!

•

This explains why true engineering articles on plastics processing techniques are the most difficult to obtain, and why published articles of this type usually have sections that are either sketchy or obvious by their omission.

Of course, we neither ask nor expect processors to divulge developments that give them an economic advantage over their competitors. Instead, we urge that management make a true evaluation of their "secrets."

Arthur M. Merrill

Editor

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A Ball-Drop Technique for Estimating Polyethylene Film Toughness

A simple, reproducible test which provides an independent measure of polyethylene film toughness.

ROSS H. SUPNIK,* *Chemist*
and
C. HOWARD ADAMS, *Group Leader*
Research Department, Plastics Division
Monsanto Chemical Co.
Springfield, Mass.

The development of a ball drop impact test for polyethylene film was undertaken in our laboratory as a part of an over-all evaluation research program on polyethylene resins. Designed primarily for estimating the "toughness" characteristic of film, especially important in packaging applications, it is a refinement of a basic technique long known and widely used in the plastics industry (1, 2).** The ball drop test was favored over the tensile test because the area under the tensile stress-strain (uniaxial) curve is not a severe enough measure of the "toughness" of a film (3).

Reproducibility within and between operators was very good for a limited number of resins of different toughness levels. No correlation has been observed between uniaxial tensile data and ball drop impact values. Thus, the method provides an independent measure of toughness, and should prove valuable as an evaluation technique for characterizing polyethylene resins and studying the effect of processing conditions on film quality.

Test Development

The ball drop apparatus used in this study is shown in Figure 1. This equipment consists of an electromagnet mounted on a 3/16-inch steel rope wrapped around two pulleys, one nine feet directly above the other. A cam locks the magnet at the desired height on the rope.

The film is mounted in a five-inch embroidery hoop which is placed in a frame and locked in position to insure uniform pressure on the film. The frame is set in a metal positioning ring fastened to the surface of a table, standing waist high off the floor. The table is bolted to the floor for firmness, and situated so that with the frame set in the positioning ring the impinging surface always falls on the center of the test specimen.

Preliminary drop ball tests were run with a one-inch steel ball-bearing weighing 66 grams. The ball was held by the magnet when the electricity was turned on, and it was released when the current was turned off. The height of the magnet was raised in one-inch increments until film failure occurred. Only one drop was made on each specimen, and several samples were run at the critical heights to establish that height below which no failure occurred. This type of test, though crude, offered promise in distinguishing between toughness of various films.

Throughout the paper, test heights refer to the height of the magnet above the film. Absolute height must be calculated from the shape and center of gravity of the dropping mechanism. All testing was performed under

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** Numbers in parenthesis refer to bibliography at end of article.

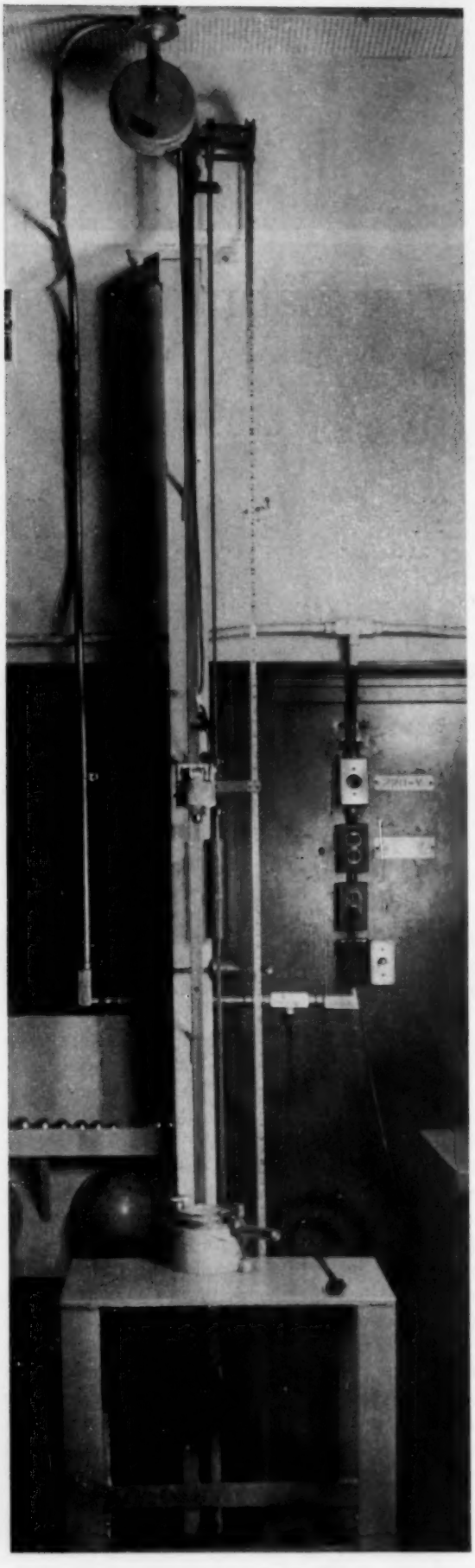

Fig. 1. Apparatus for ball drop impact test.

standard conditions (23° C. and 50% R.H.).

To improve this method before the final adoption of a testing procedure, the following factors were studied:

(1) Fixed height vs. fixed weight.
(2) Hoop diameter.
(3) Ball diameter.
(4) Statistical approach.
(5) Use of dart with removable weights.
(6) Height for best film separation.
(7) Effect of smaller dart.

Fixed Height vs. Fixed Weight

Two approaches to evaluating film toughness were apparent. One was to increase the height of a given ball until failure occurred, as done in initial experiments. The other was to increase the weight of ball at a constant height until the film failed. In the first case, velocity is varied and mass is constant; in the second case, velocity is constant and mass is varied. To account for film variability, 10 samples were required to just resist failure for a specific height or weight to be considered the no-failure point.

Both techniques were tried on four commercial films. Results are plotted in Figures 2 and 3. In Figure 2, the height above which film rupture occurs is plotted for each of three ball weights. The heavier the ball, the closer the curves and the less the separation of materials. In Figure 3, the weight above which rupture occurs is plotted for each of three test heights. The greater the height (or the higher the velocity), the poorer the separation of materials. Varying the ball weight at constant height afforded a better separation of films than varying the height at constant ball weight. However, the actual separation at a height of 18½ inches may not be as great as Figure 3 indicates because of the discrete ball sizes available (15, 35, 65, 151, 198, 287, and 358 grams). From an experimental viewpoint, a constant height is more desirable for both convenience and accuracy, since continually changing the position of the magnet can be a soure of error.

Hoop Diameter

To study the effect of hoop diameter, results obtained with an eight-inch hoop were compared with those obtained with a five-inch hoop. So that test specimens could be mounted in an identical manner, a frame identical to the five-inch one was fabricated. At a given height, heavier balls were necessary to break film mounted in the larger hoop. However, the weight of ball necessary to break film in the eight-inch hoop was found to a linear function of the weight necessary to break film in the five-inch hoop (see Figure 4). Since the smaller hoop was easier to handle, and since the same relative ranking was obtained with the two hoops, the smaller one was used throughout the subsequent development.

Ball Diameter

When at constant height the weight of ball was increased until film failure occurred, not only was the weight of the ball changing, but all the ball diameter. In

order to study the effect of changing the size of the impinging surface on the impact resistance of film, ping-pong balls were filled with various weights of steel shot. The height was increased until film failure occurred for various ball weights.

Two films were tested, and results are plotted along with those obtained with steel balls of various diameters in Figure 5. Diameters of balls used are shown in Table 1.

Table 1. Diameters of Test Balls

	Weight, gms.	Diameter, in.
Steel balls:	196	1.44
	64	1.00
	35	0.81
Ping-pong balls:	All wts.	1.50

As can be seen from Figure 5, the greater the difference in ball diameter (steel or ping-pong), the greater the difference in no-failure height. For example, at 35 grams the difference in no-failure height is 33 inches for film C, whereas at 120 grams the difference in no-failure height is only six inches. The difference in diameter at this height would be 1.5 inches for ping-pong balls, and 1.2 inches for steel. This shows that the smaller diameter introduces a stress-concentrating effect which is added to the momentum effect and, thus, results in a lower no-failure height. For this reason, a better and more realistic separation is obtained with balls of constant diameter.

Statistical Approach

Decreasing the weight of ball until 10 film specimens showed no failure appeared unduly tedious. Consequently, the number of failures in 10 samples was

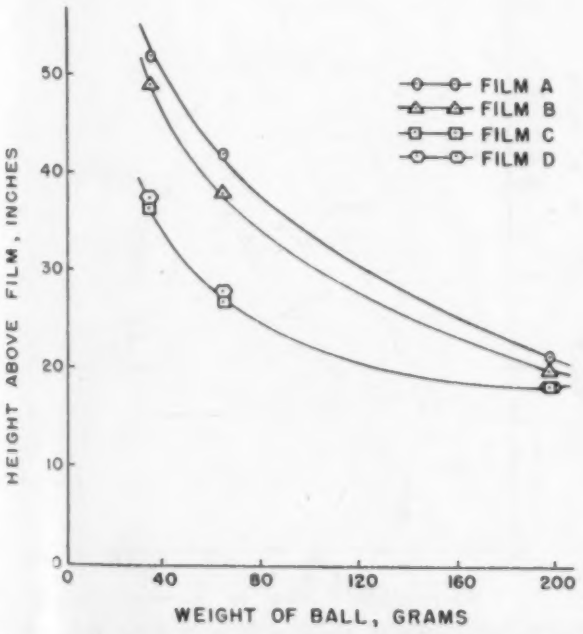

Fig. 2. Height above which film fails vs. ball weight for four polyethylene films tested by ball drop method.

Ross Harold Supnik was born in Cleveland, O., and received a B.S. in chemical engineering from Case Institute of Technology in 1949. After graduation, he worked as an analyst and junior chemist for Industrial Rayon Corp. from 1949-51, and was a research chemist in Monsanto's plastics division from June 1951 to Jan. 1956. He is currently a plastics engineer with Foster Grant Co., Inc. While with Monsanto, he represented the company in all ASTM activities related to polyethylene and, in his work for the firm, was concerned primarily with the development of tough thermoplastic molding materials. Mr. Supnik's professional memberships include SPE, AIChE, and ACS.

C. Howard Adams received a B.S. in chemical engineering from the University of Illinois in 1939, and an M.S. in mechanics from the same university in 1945. He joined Monsanto in 1945 after having been a chemical engineer for Jos. E. Seagram & Sons in 1939-40, assistant chief chemist for American Plastics Corp. in 1940-41, and a group leader for an OSRD chemical engineering project at the University of Illinois during 1941-45. At Monsanto, he is a group leader and technical service supervisor in the research department of the plastics division. In addition to membership in Tau Kappa Epsilon, Mr. Adams also is active in ASTM, AIChE, and ASME.

determined for each of several ball weights. A plot of percent failures vs. ball weight was made for each of several films, and the relationship was found to be linear. The best straight line was drawn through these points, and the line was extrapolated to zero failure to determine the no-break load. The no-break load is defined as the load below which samples do not break (for a given height).

Typical curves are shown in Figure 6. Besides increasing the accuracy of results, this technique reduced the amount of testing work. Only four points were found to be necessary; frequently, three were adequate to obtain a straight line with good reproducibility.

Dart with Removable Weights

A more compact testing unit was then made in the form of a dart. The dart consisted of a 1½-inch hemispherical phenolic base and an aluminum shaft with iron tip and several removable 15-gram weights (see Figure 7). The diameter of the base was the same as that of the ping-pong ball. The shaft was made of aluminum to keep the unloaded dart as light as possible so that the unit would be able to measure toughness of very poor films as well as very good ones.

An iron tip was pinned to the shaft so that the dart could be held by the magnet. Initially, this tip was filed to a point for centering on the magnet, but because of the lines of magnetic flux, the dart climbed to the outside of the core. Consequently, a magnet adaptor was designed with a cylindrical projection, and a corresponding shaft tip was fabricated so that the dart could be adequately centered. Weights were made of stainless steel so they would not be attracted to the magnet.

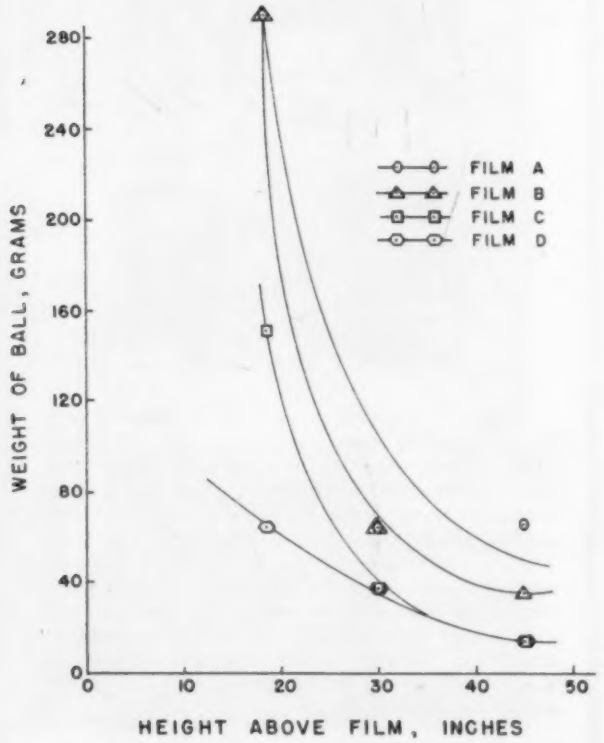

Fig. 3. Weight of ball above which film fails vs. ball height for four polyethylene films tested by ball drop method.

Height for Best Film Separation

Tests were run on three films from each of two heights to determine which would give the better separation of materials. Results are plotted in Figure 8. A much better separation was obtained at a 32-inch height than at 45 inches. The spread in no-break load was 64 grams at 32 inches as compared to only 14 grams at 45 inches. Thus, the spread obtained at the 45-inch height is only 22% of that obtained at the 32-inch height.

Effect of Smaller Dart

A ½-inch hemispherical base was tried with the dart shaft, and the removable weights were made higher and slightly less than ½-inch in diameter. At 32 inches this dart gave a much more severe test than the larger diameter one, probably due to the stress-concentrating effect noted previously. The no-break level was much lower, the slopes of the curves were steep, and differences in films could not be easily ascertained.

Method of Reporting Results

After the weight range for break-through was established, the percent failure in 10 samples was determined for each of several dart weights. The best straight line was then drawn through these points and extrapolated to zero failure (the line was not necessarily drawn through 0 and 100% failure points, since dart weights were discrete values). This extrapolated value was recorded as the no-break load. This is inferred to mean the load at and below which no sample will break. Statistically, however, a sample may break at this load.

A much better method of characterizing the film was found to be the 50%-failure load. At this weight, a sample is just as likely to fail as not. Also, the line is most accurate at the 50%-failure level from statistical

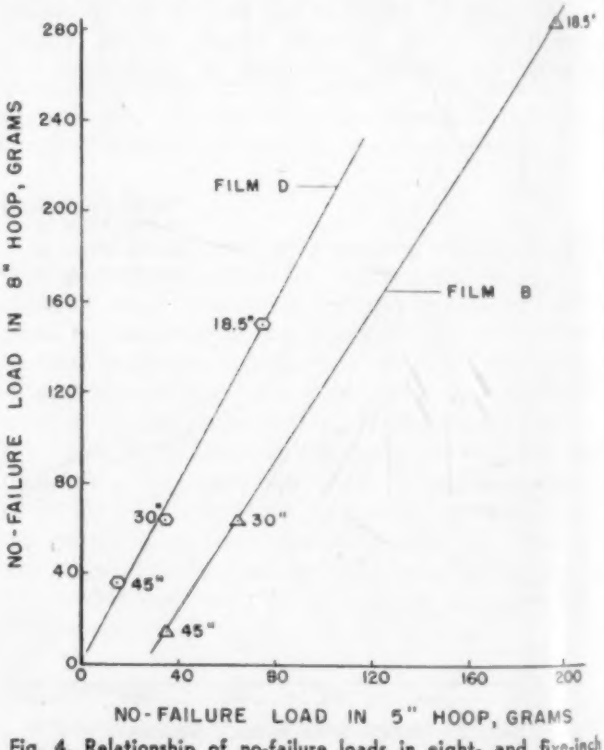

Fig. 4. Relationship of no-failure loads in eight- and five-inch hoops for two polyethylene films tested by ball drop method at three test heights.

considerations. If errors are incurred at very low or very high percent-failure levels, the error for the 50% level read from the curve is at a minimum. For complete characterization of toughness the slope of the line should be reported as well as the 50%-failure load.

Test Reproducibility

An experiment was designed to check reproducibility within samples and between operators. Each of three operators was to test three films in triplicate. Although one of the materials was not available in sufficient quantity to complete the planned experiment, a good measure of test reproducibility was obtained. Results are shown in Table 2.

Table 2. Polyethylene Film Toughness by the Ball Drop Technique, 50%-Failure Load in Grams

Film	Operators A	H	R
1	146	162	145
	144	157	148
	140	162	152
2	57	58	50
	55	59	51
	59	56	54
3	60	72	—
	66	75	—
	68	72	—

Statistical analysis of this data shows good reproducibility. The over-all deviation is less than ±8% in the case of each film. Since greater variability is noted between operators than within operators, this over-all standard deviation probably can be decreased after careful observation of operator technique.

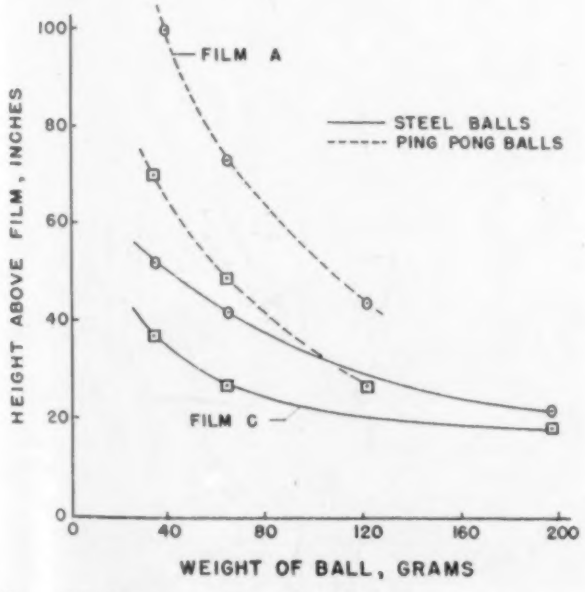

Fig. 5. Height above which film fails vs. ball weight for two polyethylene films tested by ball drop method using steel and ping-pong balls.

Correlation with Tensile Data

Several commercial films have been evaluated in our laboratory. Tensile strength and percent elongation were measured at yield and fail in both machine and transverse directions at a straining rate of 20 inches per minute. Area under each stress-strain curve also was obtained. The results of these evaluation tests are shown in Table 3. No statistical correlation could be found between ball drop impact resistance and tensile data.

Recommended Test Procedure

SCOPE AND SIGNIFICANCE. This method measures impact resistance for one size of impinging surface traveling at one velocity. It is entirely adequate for comparing resistance to shock impact of thin polyethylene films under these conditions. As such, it may be used to differentiate among resins, and should be useful in correlating extrusion conditions with film toughness.

TEST REPRODUCIBILITY. A standard deviation of less than ±10% can be expected.

APPARATUS. Dart consisting of a 1½-inch hemispherical phenolic base and an aluminum shaft with iron tip and removable weights (see A in Figure 9; also Figure 7). Five-inch embroidery hoop for mounting film samples. Holder to support embroidery hoop (see B in Figure 9). Table with positioning ring for centering holder (see C in Figure 9, and Note 1). An electromagnet (see D in Figure 9) mounted on a 3/16-inch steel rope wrapped around two pulleys, one nine feet directly above the other (see Note 2). A cam locks the magnet at the desired height on the rope, and an adaptor (E in Figure 9) is used to center the dart shaft on the magnet. The complete apparatus is shown in Figure 1.

PROCEDURE. Cut 45 film specimens measuring six inches long by six inches wide. Measure the thickness of each specimen to the nearest 0.1 mil. Place one specimen over the inside ring of the embroidery hoop, and bring outside ring down over inside ring. The film should be taut and wrinkle-free, but not stretched. Place the

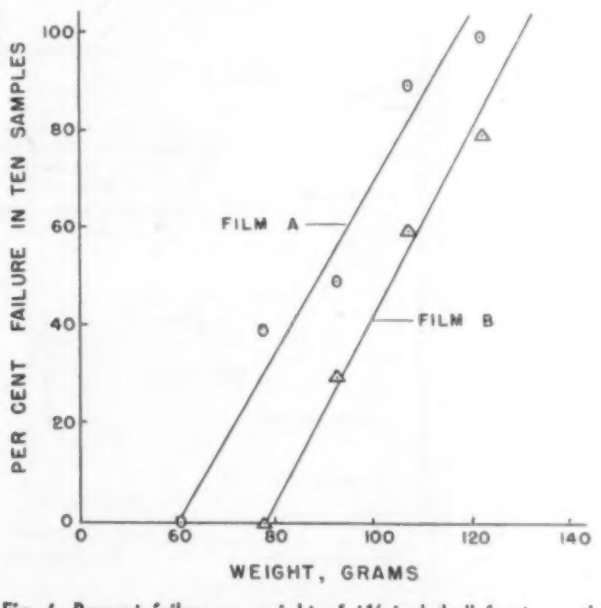

Fig. 6. Percent failure vs. weight of 1½-inch ball for two polyethylene films tested by ball drop method at height of 45 inches.

hoop in the holder which is set in the positioning ring, and tighten the clamp.

Set the release point of the magnet 32 inches above the film, and lock it at this height. Position the dart vertically with the top of the shaft mounted over the tip of the magnet adaptor. Turn on the electromagnet to hold the dart shaft, then turn off the electromagnet to release the dart. Record whether or not the film breaks on impact. The slightest tear in the film is considered a break (see Note 3).

Establish the weight range for break-through, and run 10 samples at each of four weights to yield percent failure values between 0 and 100 (see Note 4).

CALCULATION. Plot the percent failure for each dart weight against the weight of dart. Draw the best straight line through these points. Record the 50%-failure load taken from the curve, and the slope of the line (see Note 5).

An example of the data obtained is given in Table 4.

Table 4. Typical Drop Ball Impact Test Data

Dart wt., gms.	% failure of 10 specimens
75	30
90	40
105	60
120	80

This data is plotted in Figure 10 which shows the best straight line drawn through these points. The dart weight at which 50% of the samples fail is read from the curve and found to be 96 grams. The slope is calculated as follows:

$$\text{Slope} = \frac{\text{Ordinate}}{\text{Abscissa}} = \frac{100}{147\text{-}45} = \frac{100}{102} = 0.98$$

NOTES.

(1) The positioning ring is mounted on the surface of the table so that with the holder set in the ring, the dart always falls in the center of the hoop.

(2) This apparatus was devised to measure impact resistance at various heights. For purposes of this test, a permanent mounting 32 inches above the surface of the film is adequate.

(3) In case of doubt, a break can be readily observed by holding the hoop up to the light.

(4) The nature of the break generally shows whether the dart is too heavy or too light. Weights giving 100% failure or 100% no-failure are of only qualitative significance, but those weights giving failures between 0 and 100% provide a quantitative measure of toughness.

(5) The slope of the line may be an indication of the uniformity of the film; the higher the slope, the greater the uniformity. It may also merely reflect the sensitivity of the film to shock impact under these conditions. A steep slope at a relatively high weight range is most desirable.

Discussion of Test

This procedure for measuring resistance to shock impact should be most helpful to both resin suppliers and converters. Here is a technique that provides a reproducible measure of toughness. With it, materials can be differentiated readily, and the effects of extrusion conditions on film quality can be determined. Likewise, the effects of handling, printing, storage, etc., can be readily ascertained. Correlation of impact results with specific end-use applications will provide an intelligent basis for film specifications.

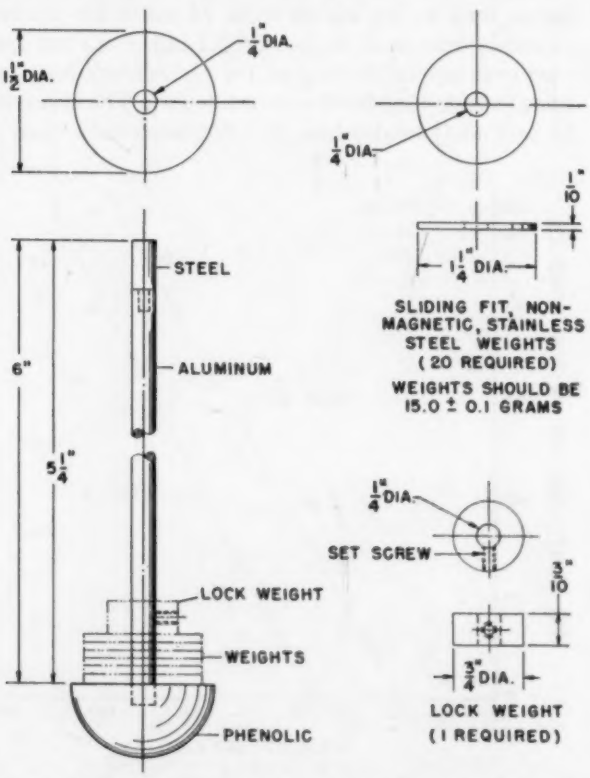

Fig. 7. Details of dart and removable weights used in drop ball impact test.

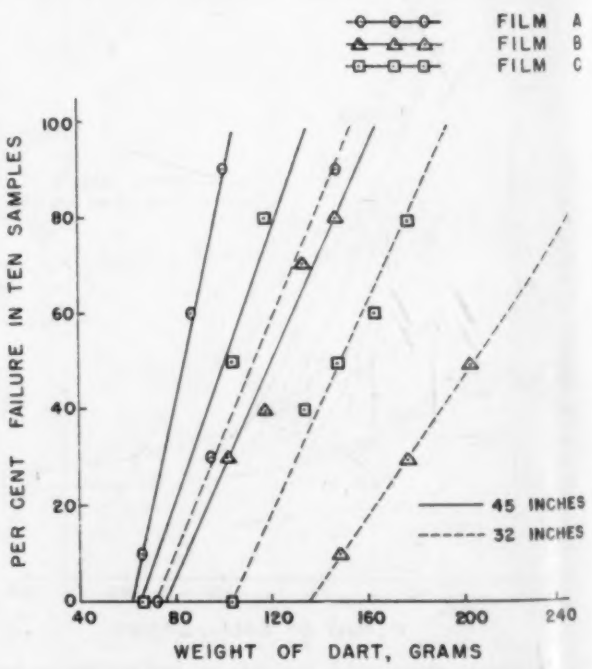

Fig. 8. Percent failure vs. dart weight for three polyethylene films tested by ball drop method at 32- and 45-inch heights.

Since impact resistance cannot be statistically correlated with tensile (uniaxial stress) data obtained with straining rates as normally used, the ball drop (multiaxial stress) test provides an independent measure of toughness. However, results obtained by complex stressing in a manner described by Hopkins et al (3) may very well correlate with ball drop impact resistance. In applications where materials are subjected to multiaxial stresses, materials fail at strains far less than would be expected from conventional uniaxial tests. This ball drop technique provides a simple, precise means of measuring toughness of multi-axially oriented film.

For control purposes, the amount of testing can be decreased substanially. If the slope of the line obtained by plotting percent failure against dart weight is the same for a given process or a given material, only 10 samples need be run. The percent failure with one predetermined dart weight is enough to tell whether the process is in control.

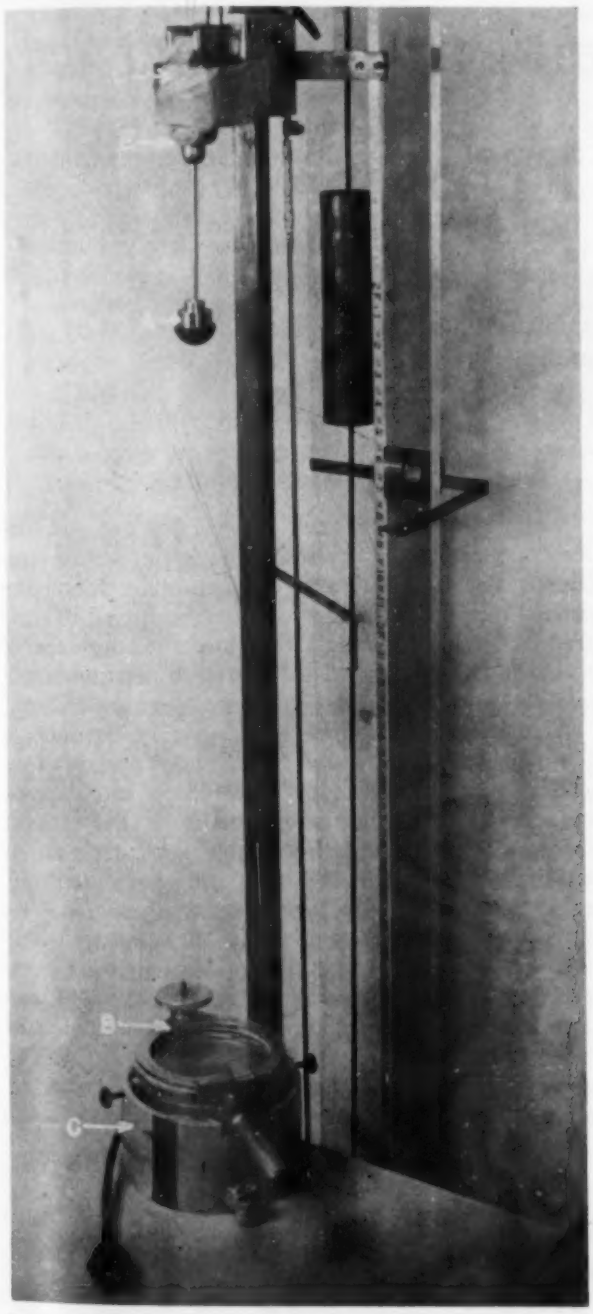

Fig. 9. Details of test apparatus: A—Dart; B—Specimen holding hoop; C—Positioning ring on specimen table; D—Electromagnet; and E—Adapter for centering dart.

If the slope of the line varies, however, then the entire curve must be obtained. The slope of the line may be an indication of the uniformity of the film; the higher the slope, the greater the uniformity. It also may merely reflect the sensitivity of the film to shock impact under these conditions. A steep slope at a relatively high weight range is most desirable.

From statistical theory, the continuous curve is obtained by plotting percent failure against dart weight is called a Probit Curve (4). This curve slopes up gradually at low percentages, passes through a point of inflection, rises sharply until about 80 or 90%, then passes through another point of inflection and slopes off gently.

Statistically, therefore, a plot of percent failure against dart weight should give a better straight line on probability paper or logarithmic probability paper. Because of the discrete weight increments chosen in this procedure, however, an arithmetic plot appears to be linear and gives comparable accuracy. Because the weight increments are discrete, the line need not be drawn through 0 and 100%-failure points, and these points should act only as guides or limits for the curve.

Results are reported as the weight at which 50% of the samples fail, sometimes referred to in statistical circles as the mean-break strength. This can be converted into terms of energy absorbed on impact by multiplying dart weight by the height from which it is dropped. The distance from the top of the dart to the film is 32 inches, while the drop is only 26 inches from the bottom of the dart. For an accurate measure of energy absorbed by the film, however, the center of gravity of the dart and the indentation of the film on impact should be taken into consideration.

How ball drop resistance varies with thickness of film has not been clearly established. When the thickness is

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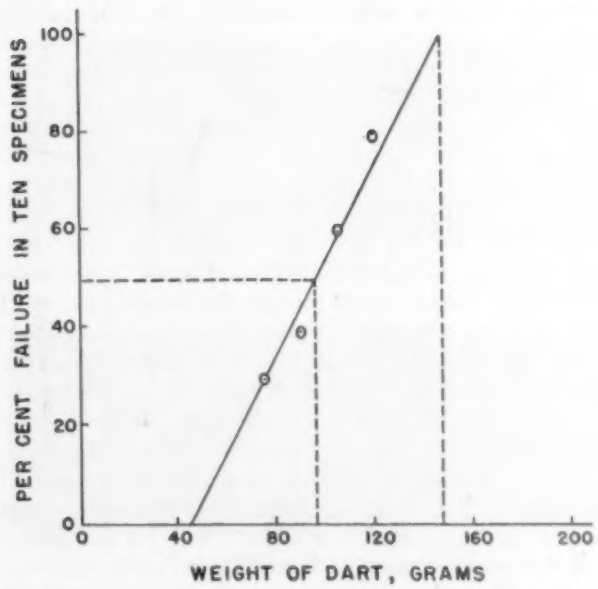

Fig. 10. Ball drop impact characteristics of an experimental polyethylene film.

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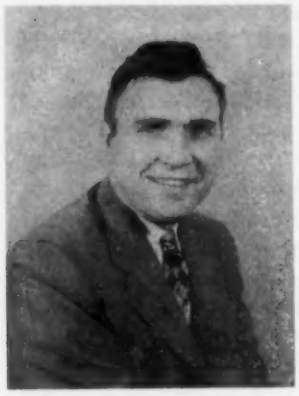

Preheating Polyethylene and Impact Polystyrene Prior to Extrusion

Results of a quantitative study of the benefits obtained by preheating polyethylene and impact polystyrene before extrusion.

The absorption of excessive moisture in plastic compounds ordinarily results in an extruded product which is poor in appearance and contains many voids. To eliminate these adverse effects, the preheating of such materials prior to extrusion is recommended. Since this void problem is not of paramount importance to all who extrude polyethylene and impact styrene, an investigation was undertaken to determine if other advantages could be gained through the use of preheating both for moisture-free and moisture-sensitive compounds. This report contains the results of such an investigation into both materials.

Polyethylene

Resins and Equipment Evaluated

There are various means by which plastic compounds may pick up sufficient moisture to result in extrusion difficulties. These include pick-up during the process of manufacture, absorption during storage, and by condensation when brought from cold temperatures into a warmer, moist atmosphere. Previous work had established 0.05% moisture as the maximum that could be tolerated without impairing product quality. As a starting point in this investigation, therefore, the compound selected was a former polyethylene pipe compound with a history of moisture absorption. This compound had a moisture content of 0.06-0.75% despite only two months of storage in a polyethylene-wax coated (20 pounds per ream) paper bag.

While most of the work was carried out with this compound, normally dry resins and hot processed compounds also were subjected to preheating. Results indicated that the benefits were common for all of these grades of polyethylene and, therefore, the advantages of preheating are not restricted merely to moisture-sensitive materials.

A conventional two-inch Royle machine extruding a 1⅝-inch flat tape was used in the major portion of the work. A range of preheating temperatures, screw speeds, and screw temperatures was explored. Once the results of preheating were determined on this particular unit, experiments were conducted with other extruders producing other shapes to determine whether or not the preheating results were common to all equipment.

In all, a total of four extruders was employed in extruding the shapes shown in Table 1. Preheating advantages were found to be comparable for all machines and products extruded.

Extruder	Shape Extruded
2-inch Royle	1⅝-inch flat tape
With modified head	2-inch tubing
2½-NRM	½-inch tubing
3¼-inch Royle	flat Film

Preheating Methods

Two methods of preheating were investigated, oven heating and a commercial hopper dryer. Of the two methods, the hopper dryer was the more satisfactory one for several reasons. Foremost, it was a continuous method, the material being fed directly to the hopper where the drying and heating took place. This eliminated the double handling necessary with oven preheating. Another important consideration was the efficient heating it provided, requiring 35 minutes as compared to 60 minutes of oven heating to obtain satisfactory extruded product quality.

As expected, preheating time varied with moisture content. In compounds containing an excessive amount of moisture (0.10%), 60 minutes of hopper drying were required as compared to 75 minutes of oven heating. The portable feature of the hopper-dryer, compared to the fixed installation of the oven, was considered another advantage of the former unit.

The oven used was a steam heated, circulating air unit equipped with a temperature controller. Cold material was charged in trays filled to a depth of approximately one inch to ensure effective preheating, and then fed batchwise to the extruder.

The hopper-dryer was an electrically heated commercial unit of intermediate size. Preheating was carried out directly in the hopper section of the extruder by means of forced hot air. A schematic diagram of this unit is shown in Figure 1. With the temperature controller at its maximum setting of 100° C., the unit was able to raise the temperature of the granules to 84-88° C., the exact temperature depending on the extrusion rate.

The length of time required to reach fair and good quality levels starting with cold resin and an empty hopper (capacity 45 pounds) is shown in Table 2. The particular hopper-dryer used was of intermediate size.

Table 2. Preheating Conditions for Hopper-Dryer

Screw speed, rpm.	Extrusion rate, lbs./hr.	Preheating Time, Min. Fair Quality	Required to Attain Good Quality
12	18.8	20	25
30	43.3	25	32
45	61.3	30	35
60	76.4	35	40

Preheating Temperatures

In the oven preheating experiments, it was determined that 90° C. represented the highest safe preheating temperature. At 95° C., the pellets became very soft, resulting in some adhesion to the trays. At 100° C., considerable fusing of the pellets occurred, thus rendering the compound unusable for extrusion in machine with small feed openings.

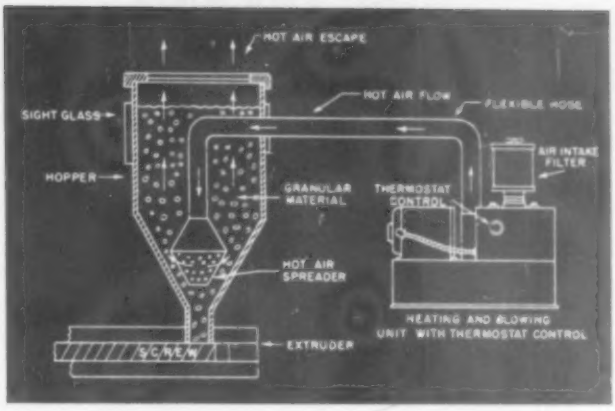

Fig. 1. Schematic diagram of hopper-dryer.

Benefits of Preheating

Preheating polyethylene prior to extrusion results in the following benefits:

(1) Improved visual product quality. This is the most widely recognized benefit of preheating and applies specifically to compounds containing moisture. In such compounds, preheating eliminated surface roughness while improving surface gloss. This is illustrated in Figure 2, which shows extruded surface produced from preheated and unpreheated feeds.

It is important to mention that the deleterious effects of moisture in unpreheated compounds are not apparent in all conditions of operation. At low extrusion temperatures and in shapes of relatively small but heavy cross-section (e.g., one-inch pipe), there is no visual effect on product quality. However, when high temperatures are used, as is necessary when extruding large, thin sections, the effects of moisture are pronounced. This ability to bring out these effects under certain conditions of operation may account for the more critical results reported by some customers and not by others for the same compound. In the case of non-moisture sensitive polyethylene, preheating did not visually affect product quality.

Fig. 2. Comparison of extruded polyethylene surfaces produced by unpreheated and preheated feeds.

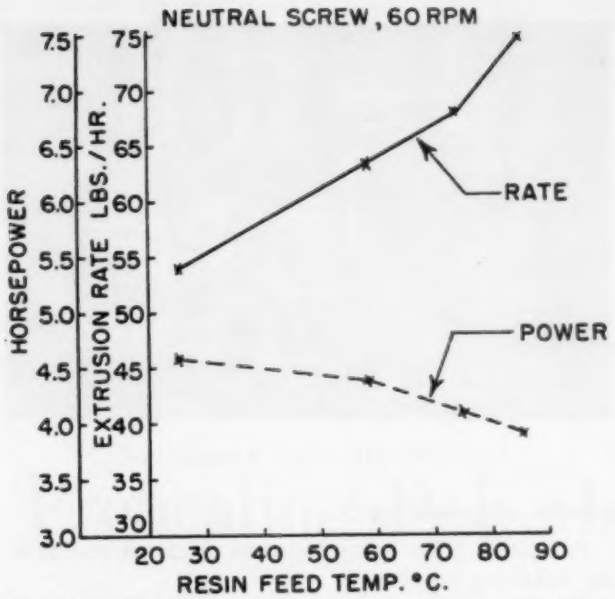

Fig. 3. Effects of hopper-dryer preheating on black polyethylene extrusion performance with neutral screw at 60 rpm. (2-inch Royle extruder, 1-5/16-inch tape die).

(2) Increased extrusion rates. In all cases, the extent of improvement varied directly with temperature, the highest preheating temperatures providing the highest extrusion rates. This is illustrated in Table 3 showing the results obtained when operating at a screw speed of 60 rpm. and neutral screw conditions.

More detailed results of the effects of preheating temperatures on extrusion rates are graphically illustrated for hopper preheating in Figures 3 and 4, and for oven preheating in Figure 5. Pertinent data are summarized in Tables 4 and 5 for hopper preheating, and in Table 6 for oven preheating.

The greatest difference between preheated and unpreheated feeds occurred when a neutral screw (i.e., neither steam nor water control) was used (see Figure 6). Thus, over the entire screw speed range of 12.5-84 rpm., preheated feed resulted in an extrusion rate increase of 38-49%. At low controlled screw temperatures (30 and 50° C.), the benefits of preheating were not as marked, as evidenced by the lower 16.4-22.6% increases in extrusion rate (see Table 4).

Table 3. Effect of Feed Temperature on Extrusion Rate

Resin Feed Temp., °C.	Extrusion Rate Lbs./Hr.	Extrusion Rate % Increase
25	54.1	....
58	63.0	16.4
74	67.8	25.3
85	74.6	37.9

As the extrusion rates increased, a corresponding increase in screw efficiency occurred, raising this from a range of 37-46% for cold feed to a range of 53-69% for preheated feed (Table 5 and Figure 7). Screw efficiency is defined here as the ratio of the actual to the theoretical output of an extruder screw.

(3) Extruder drive (horsepower) requirements decrease. These decreases are inversely proportional to preheating temperatures and occurred despite marked simultaneous increases in extrustion rates. For example, operating at a screw speed of 60 rpm. and neutral screw conditions, the results shown in Table 7 were obtained:

With controlled screw temperatures of 30 and 50° C., the reduction in power is less marked as evidenced by the 3.5 and 10.3% decreases, respectively (see Table 4). The greatest benefit, however, is always derived from preheating at the highest temperature, as illustrated in Figures 3 and 4 for hopper preheating and in Figure 8 and Table 6 for oven preheating. Power requirements also remain consistently lower through the use of preheated feed over the entire range of screw speeds, as illustrated in Table 5 and Figure 9.

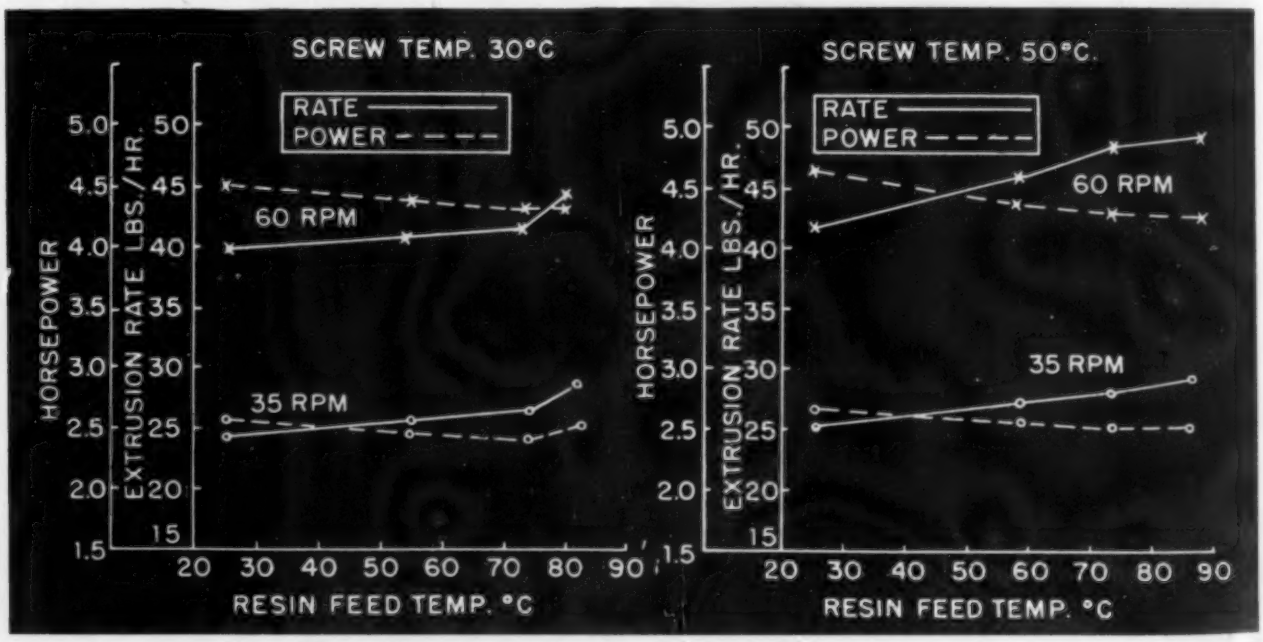

Fig. 4. Effects of hopper-dryer preheating on black polyethylene extrusion performance at two screw temperatures (2-inch Royle extruder, 1-5/16-inch tape die).

Table 4. Effects of Preheating Temperatures on the Extrusion Performance of Black Polyethylene (Hopper-dryer, 2-inch Royle extruder, 1-5/16-inch tape die).

Screw Speed, Rpm.	Screw Temp. °C.	Hopper Temp. Setting, °C	Feed Resin Temp. °C.	Product Quality	Extrusion Rate		Power (Extruder Drive)		Compound Temp., °C.
					Lbs./Hr.	% Increased	H.P.	% Decrease	
35	30	Off	25	Poor	24.4	—	2.56	—	190
		50	55	Good	25.5	4.5	2.46	3.91	192
		75	74	Good	26.4	8.2	2.40	6.25	192
		90	82	Very Good	29.2	19.6	2.56	00	193
	50	Off	25	Poor	25.6	—	2.68	—	195
		50	58	Good	27.4	7.0	2.57	4.10	197
		75	73	Good	28.3	10.5	2.51	6.34	205
		90	82	Very Good	29.2	14.1	2.51	6.34	210
		100	86	Very Good	29.8	16.4	2.51	6.34	220
60	30	Off	25	Poor	40.3	—	4.49	—	178
		50	54	Fair	41.6	3.2	4.39	2.22	178
		75	73	Good	41.5	2.9	4.33	3.56	176
		90	80	Good	49.4	22.6	4.39	2.22	175
	50	Off	25	Poor	42.1	—	4.65	—	190
		50	58	Fair	46.2	9.7	4.39	5.59	200
		75	73	Good	48.8	14.9	4.33	6.88	189
		90	85	Good	50.4	19.7	4.28	7.96	190
		100	88	Good	49.6	17.8	4.17	10.32	190
	Neutral	Off	25	Poor	54.1	—	4.60	—	185
		50	58	Fair	63.0	16.4	4.39	4.57	185
		75	74	Good	67.8	25.3	4.12	10.43	175
		90	82	Good	74.6	37.9	3.91	15.0	172
		100	85	Good	74.6	37.9	3.91	15.0	175

Table 5. Comparison of the Extrusion Performance of Preheated and Unpreheated Black Polyethylene (Hopper-dryer, 2-inch Royle extruder, 1-5/16-inch tape die, neutral screw)

Screw Speed, Rpm.	Resin Feed Temp., °C.	Extrusion Rate		Extrusion Efficiency	Power (Extruder Drive)		Compound Temp., ° C.
		Lbs./Hr.	% increase		H.P.	% Decrease	
12½	25	12.60	—	46.30	0.96	—	210
12½	88	18.84	49.5	69.23	0.85	11.11	210
30	25	30.06	—	45.93	2.03	—	195
30	86	43.32	44.1	66.32	1.77	12.80	195
45	25	44.32	—	44.23	3.10	—	190
45	86	61.32	41.3	62.52	2.89	6.77	190
60	25	55.32	—	42.35	4.28	—	185
60	85	76.44	38.1	58.52	3.95	7.71	182
84	25	68.28	—	37.33	6.52	—	180
84	84	97.32	42.5	53.22	6.04	7.36	178

Table 6. Effects of Oven Preheating on the Extrusion Performance of Black Polyethylene (2-inch modified high-temperature head extruder; 2-inch tubing die, neutral screw at 30 rpm.)

Preheat Temp., ° C.	Feed Resin Temp., ° C.	Product Quality	Extrusion Rate		Power (Extruder Drive)		Compound Temp., ° C.
			Lbs./Hr.	% Increase	H.P.	% Decrease	
Room Temp.	25	Poor	25.1	—	2.30	—	225
50	49	Very good	28.8	14.74	2.14	6.95	212
75	72	Very good	31.8	26.70	2.08	9.56	212
95	91	Very good	36.9	47.01	2.08	9.56	212

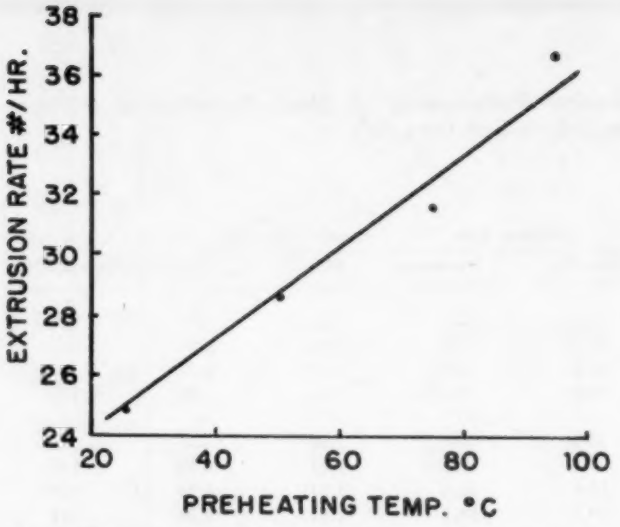

Fig. 5. Effect of oven preheating temperature on extrusion rate of black polyethylene (modified high-temperature head extruder, 2-inch tubing die, neutral screw at 30 rpm.).

It is of interest to note that the use of preheated feed also results in much less power fluctuation by the extruder drive, particularly at the higher screw speeds. The differences in power fluctuation between cold and hot feeds amounts to 300 watts at the highest screw speed (see Table 5). Although of seemingly relatively minor importance, this improvement through preheating must be presumed to have a beneficial effect on the dimensional uniformity of the product by minimizing extruder surging tendencies.

(4) Despite marked increases in extrusion rates through preheating, extrusion compound temperatures did not drop appreciably lower than those recorded for the unpreheated product. Only in one instance and at a very high extrusion rate did this temperature drop more than 5° C. (see Table 4 and 5). This is an important consideration where the heat input of an extruder is near capacity and lower compound temperatures would adversely affect product appearance and uniformity.

(5) Physical properties of one-mil film made from the moisture-sensitive compound were significantly improved; the greatest benefits occurring in specular gloss, tensile strength and in falling ball impact. A comparison of various properties of film made from preheated and unpreheated black polyethylene is given in Table 8.

Table 7. Effect of Preheat Temperature on Extruder Drive Requirements

Feed Resin Temp., °C.	Extrusion Rate, Lbs./Hr.	Extruder Drive H.P.	Extruder Drive % Decrease
25	54.1	4.6	....
58	63.0	4.4	4.6
85	74.6	3.9	15.0

Table 8. Properties of One-Mil Polyethylene Film Made With and Without Preheated Feeds

	Unpreheated	Preheated (85° C.)
Specular gloss, mils	14	22
Tear resistance, gms./mil:		
Machine direction	93	115
Transverse direction	181	196
Tensile strength, psi.:		
Machine direction	1620	2020
Transverse direction	480	1290
Elongation, %:		
Machine direction	285	325
Transverse direction	155	530
Impact, Falling ball, (feet to break)	0.5	2.0

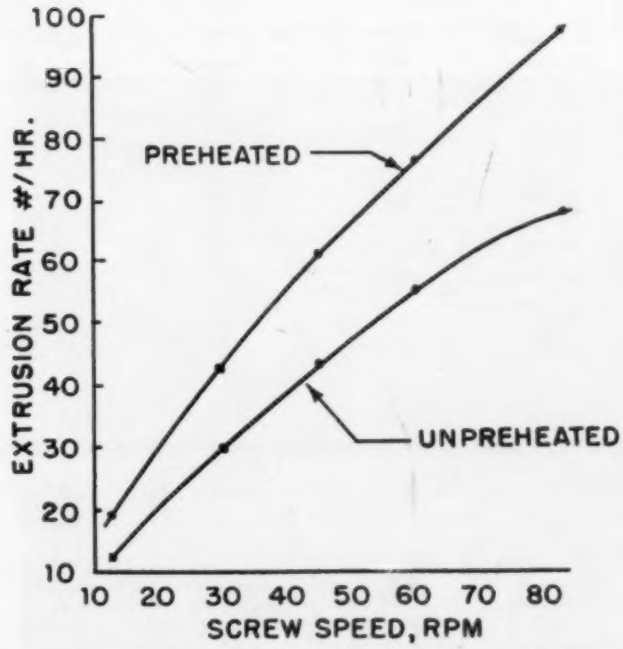

Fig. 6. Comparison of extrusion rates of unpreheated and preheated black polyethylene with neutral screw and feed temperature of 84-88° C. (Hopper-dryer preheating; 2-inch Royle extruder with 1-5/16-inch tape die).

A comparison of the physical properties of other products of larger cross-section, such as pipe and tape, revealed little difference between the use of preheated and unpreheated feeds. While it was reasoned that a product with some porosity and surface roughness would tend to exhibit poorer physical properties, short-term bursting (hoop) stress tests made on a comparatively large number of ½-inch pipe (0.840 inch O.D. x 0.109 inch wall) indicated no significant difference; 1,046 psi. preheated vs. 1,042 psi. unpreheated. Similarly, in the case of extruded tape, 1⅝ inch x 3/16 inch thick, the tensile values were 1,590 vs. 1,570 psi. for preheated and cold feeds, respectively. A more detailed coverage of results is given in Table 9.

(6) Less degradation, molecular or otherwise, is indicated through preheating. As an example, the melt index values of variously processed black polyethylene at 60 rpm. and neutral screw conditions are shown in Table 10. Melt index values of DYNH-3 under similar and other conditions of processing are listed in Table 9 and show the same trend.

(7) Results of compounding tests by dry-coloring resin revealed no difference between the use of preheated and unpreheated feeds. A dry blend of DYNH-3

Table 9. Melt Index, Tensile, and Elongation Properties of Preheated Vs. Unpreheated Black Polyethylene (Hopper-dryer, 2-inch Royle extruder, 1-5/16-inch tape die).

Resin Description	Reed Resin Temp., ° C.	Screw Temp., ° C.	Screw Speed, Rpm.	Extrusion Rate, Lbs./Hr.	Melt Index, Gms. in. 10 min.	Tensile Str., psi.	Elongation %
DYNH	—	—	—	—	1.59	—	—
	25	Neutral	60	55.9	1.76	1,570	640
	84			80.3	1.66	1,450	545
	25	50		37.2	1.74	1,530	700
	84			45.0	1.66	1,590	715
DGDB-64962 Black 10	—	—	—	—	0.95	—	—
	25	Neutral	60	56.5	1.18	1,670	670
	84			81.0	1.08	1,630	530

and a red masterbatch (deep red #10156) in such proportions as to give a 0.1% pigment concentration in the final product was extruded at relatively high rates with both a cold (30° C.) and a hot (100° C.) screw. Extrusion with the cold screw gave good compounding results with both preheated and cold feeds, whereas the compounding results were equally poor for the two feeds with the hot screw.

Preheating of polyethylene resulted in the seven benefits discussed above, with no compensating deleterious effects.

Impact Polystyrene

When the investigation of preheating polyethylene disclosed a number of important extrusion benefits, the need for determining the effect on other plastics was indicated. Consequently, a similar investigation was carried out with the impact polystyrene compounds TGD-5001 Green 65 and White 15. This particular investigation was limited to the use of two extruders only, a two-inch conventional Royle and a modified two-inch Royle. The study also was limited to operation with a neutral screw since the effects of these variables had already been explored in the earlier investigation.

As in the case of polyethylene, previous work had established a moisture content of 0.05% as the maximum tolerable in the compounds to permit the extrusion of a product of satisfactory quality. The two TGD-5001 compounds were selected because of their availability in store, and were found to have a moisture content of 0.1% after storage for only 3-4 months in a polyethylene-lined (10 pounds per ream) paper bag.

The procedures used in developing this information were similar to those already described for polyethylene and, therefore, will not be repeated except for reporting slight differences in results.

Table 10. Effect of Processing on Polyethylene Melt Index

	Melt Index	% Increase
As received	0.95	....
Preheated and extruded	1.08	13.6
Unpreheated and extruded	1.18	24.2

Both a hopper-dryer and a circulating hot air oven were used. Here, again, the former was found to be the more efficient of the two units. For example, the hopper-dryer required 45 minutes to dissipate moisture in the compound and to improve product quality, as compared to 75 minutes of oven preheating. The hopper-dryer, however, was unable to raise the resin feed temperatures above 80° C., compared to 84-88° C. for polyethylene, despite operation at the maximum (100° C.) setting of the unit in both cases.

A longer time also was required to accomplish this for the impact polystyrene; i.e., at a screw speed of 35 rpm., 40 minutes were required to reach the maximum feed resin temperature, as compared to 18 minutes for polyethylene. While the exact reason for this time difference is not known, it may possibly be due to the smaller particle size and lower bulk factor of the polystyrene (1.67 vs. 1.92) which impeded the hot air flow through the dryer, and possibly to the higher moisture content of the polystyrene compound.

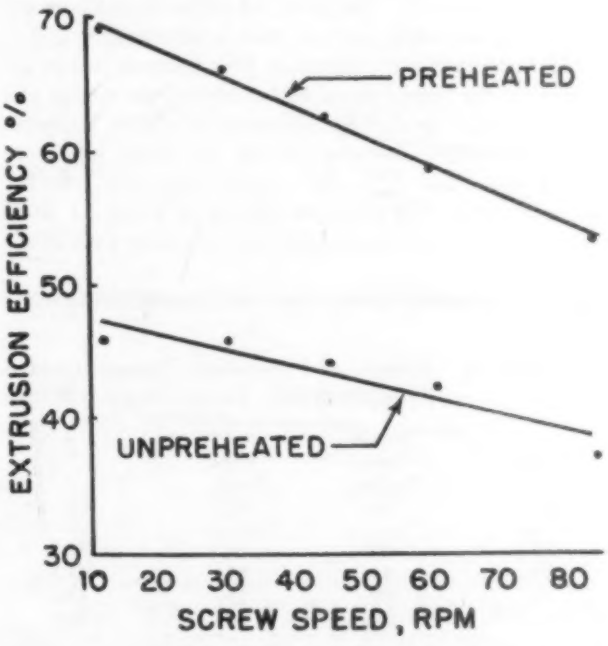

Fig. 7. Comparison of extrusion efficiencies of unpreheated and preheated black polyethylene with neutral screw and feed temperature of 84-88° C. (Hopper-dryer preheating; 2-inch Royle extruder with 1-5/16-inch tape die).

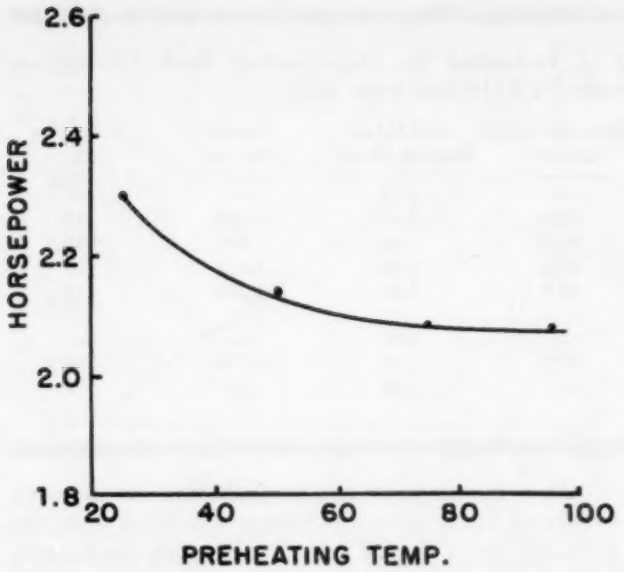

Fig. 8. Effect of oven preheating temperature on extrusion drive power of black polyethylene (2-inch modified high-temperature head extruder, 2-inch tubing die, neutral screw at 30 rpm.).

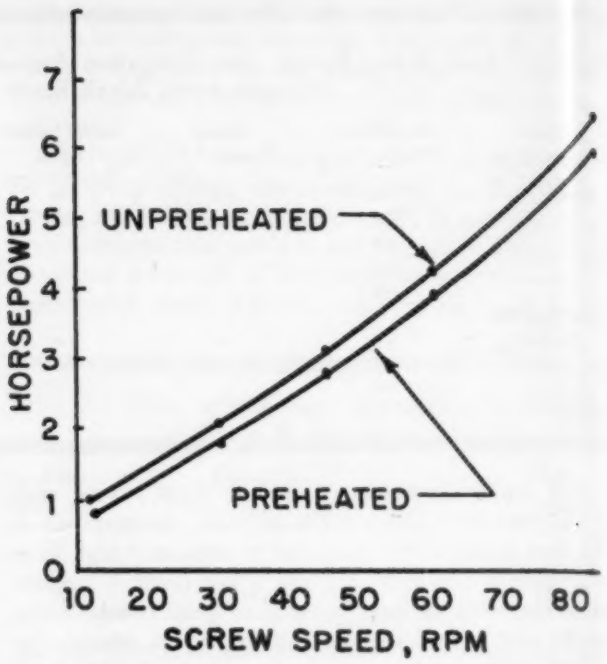

Fig. 9. Comparison of extruder power requirements for unpreheated and preheated black polyethylene with neutral screw and feed temperature of 84-88° C. (hopper-dryer preheating; 2-inch Royle extruder with 1-5/16-inch tape die).

The maximum safe preheating temperature, as determined by oven heating experiments, was found to be 85° C.

Benefits of Preheating

The following benefits and effects are derived from preheating high impact polystyrene prior to extrusion. In all cases, a neutral screw (neither steam nor water control) was used, since this is the universal condition in the field and at Bakelite for the extrusion of these compounds.

(1) Product quality is markedly improved by the dissipation of moisture. Alligator-like surfaces and porosity are eliminated, while surface gloss is improved.

(2) Extrusion rates increase. This increase varies directly with the temperature, and at high screw speeds and high preheating temperatures results in a 20% improvement. A similar increase occurs in screw efficiency raising this from 58% for a cold feed to 70% for preheated feed. The example shown in Table 11 illustrates the effect of temperature on extrusion rate at the moderate screw speed of 35 rpm. The complete results on the effect of preheating temperatures on extrusion rates are given in Table 12 and shown graphically in Figure 10.

Table 11. Effect of Feed Temperature on Extrusion of Impact Polystyrene

Feed Resin Temp., °C.	Extrusion Rate Lbs./Hr.	Extrusion Rate % Increase
30	48.7	....
58	51.6	5.9
80	54.0	10.8

(3) Extruder (drive) horsepower requirements decrease a maximum of 9% with increasing preheating temperatures. This occurs despite a simultaneous increase

Table 12. Effects of Preheating Temperatures on Extrusion Performance of High-Impact Polystyrene (Hopper-dryer, 2-inch Royle extruder, 1-5/16-inch tape die, neutral screw).

Screw Speed, Rpm.	Hopper Temp. Setting, °C.	Feed Resin Temp., °C.	Extrusion Rate Lbs./Hr.	Extrusion Rate % Increase	Screw Efficiency	Extruder Drive Power H.P.	Extruder Drive Power % Decrease
35	Off	30	48.7	—	72.35	2.99	—
35	50	58	51.6	5.95	76.66	2.94	1.67
35	75	72	53.6	10.1	79.63	2.88	3.68
35	100	80	54.0	10.8	80.22	2.72	9.03
60	Off	50	66.9	—	57.97	4.76	—
60	100	80	80.6	20.4	69.84	4.49	5.67

Table 13. Properties of Impact Polystyrene Tapes Made With and Without Preheated Feed

	Unpreheated (Feed Resin 30° C.)	Preheated (Feed Resin 80° C.)
Extrusion plastometer, gms./100 sec	0.57	0.565
Tensile strength, psi.	3,150	3,200
Ultimate elongation, %	2	4
Flexural strength, psi.	5,390	5,350
Modulus of elasticity	263,000	278,000
Izod impact strength, energy to break per inch of notch	0.77	1.00
Heat distortion point, °C.	79.9	80.2

of 10.8% in extrusion rate (see Table 12 and Figure 11).

(4) There was no significant difference in physical properties between preheated and unpreheated products. Unlike the results of polyethylene preheating where melt index values for unpreheated products increased 5-10% more than their preheated counterparts, there was virtually no difference in extrusion plastometer values for high impact polystyrene. For example, resin before extrusion had an extrusion plastometer value of 0.425 gms./100 sec. at 200° C. and 100 psi., while values for preheated and unpreheated increased to 0.565 and 0.57, respectively. While this difference in values before and after extrusion shows considerable mechanical working and breakdown taking place in the extruder, it is evident that preheating does not alter this to any appreciable degree. A summary of results on the physical properties of extruded white tape is given in Table 13.

No compounding tests of any kind were attempted because the compounds used were already colored and compounded.

The preheating of impact polystyrene, therefore, results in similar but less marked benefits than those obtained with polyethylene. Preheating succeeds in improving product quality, improving productive capacity, and lowering extruder drive requirements. As with polyethylene, this is accomplished without deleterious effects.

Summary and Conclusions

Polyethylene

In the case of polyethylene, it was found that the temperature could be as high as 90° C. Beyond this temperature, there was a tendency for the granular material to aggregate. The following results were observed when polyethylene was processed in a drier at 90° C.:

(1) Product quality was improved in moisture-sensitive compounds due to the drying effect. Surface roughness and porosity were minimized, and gloss was improved. Little visual difference was observed when moisture-free polyethylene was preheated.

(2) Extrusion rates were improved by as much as 38-49%.

(3) Screw efficiency was increased from an average of 41% to an average of 61%.

(4) Extruder drive (horsepower) requirements were reduced by a maximum of 15%. This decrease occurs despite a simultaneous increase in extrusion rates. This is of major importance in those installations where higher extrusion rates, while desirable, are prohibitive, because of operation at the maximum capacity of the extruder drive.

(*Continued on page 178*)

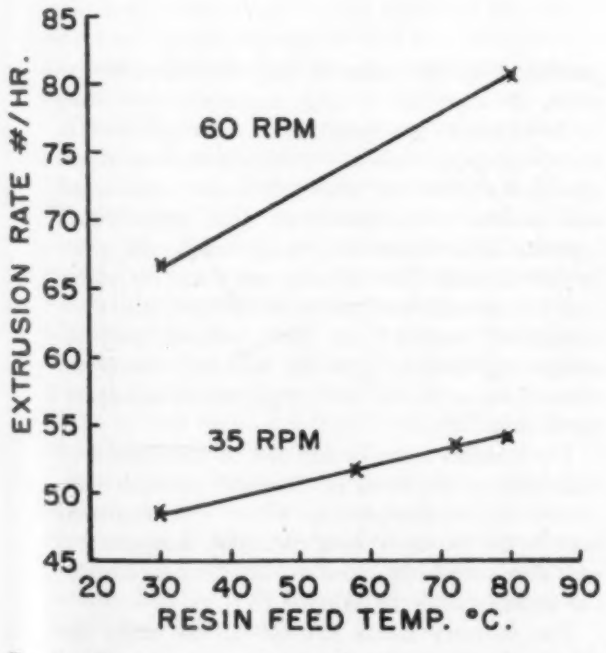

Fig. 10. Effects of hopper-dryer preheating on extrusion rate of impact polystyrene (2-inch Royle extruder with 1-5/16-inch tape die and neutral screw).

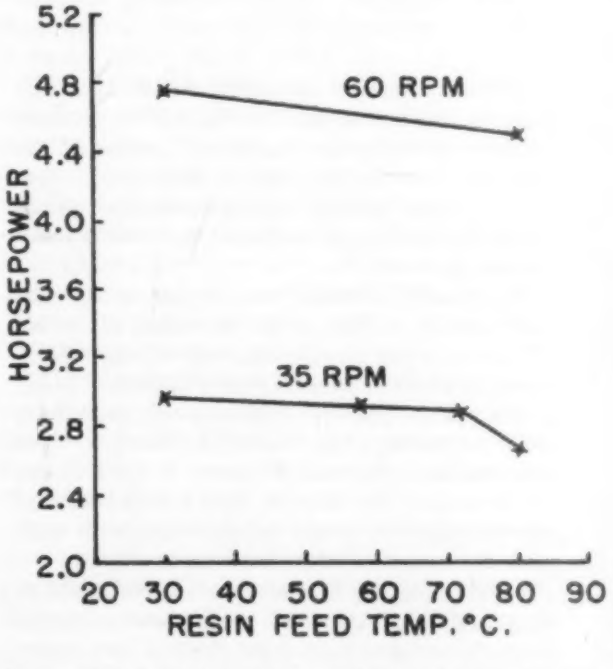

Fig. 11. Effects of hopper-dryer preheating on extruder power requirements for impact polystyrene (2-inch Royle extruder with 1-5/16-inch tape die and neutral screw).

Guest Editorial

The Need for Plastic Material Standardization and Classification

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An army that is advancing relatively freely must be contained and controlled by a commandant in order that individual groups of the army do not deviate from a fixed plan. Such control insures uniformity of purpose, and guards against the havoc and confusion that would result without this control.

The plastics industry, too, is advancing relatively freely, mainly as an uncontrolled group. The peeve is the inconsistency of the methods of obtaining physical data on plastic materials. Many of the ASTM physical tests are not particularly suited for testing plastic materials. However, until such time as a more suitable group of test methods are developed, the least to expect would be that material suppliers would be consistent with each other by using like ASTM test methods.

For example, the following are methods used to obtain "impact" data on various thermoplastic materials, as taken from eight physical data sheets published by the material suppliers. Charpy impacts are reported in four instances; two being in foot-pounds per cubic inch, the other two in foot-pounds per inch of width, and the results are obtained at various temperatures for unnotched and molded-notch specimens. Izod impacts are reported in 22 instances, but the results are given in foot-pounds, foot-pounds per inch of notch, and foot-pounds per inch of width; specimens are unnotched, notched, or have molded notches; notches are standard, gate-end, and dead-end types; tests are at room and low temperatures; and specimens sizes vary.

The inability to make any sort of comparison of materials on the basis of "impact" strength data offered is self-explanatory. Other test methods, such as for hardness, heat distortion temperature, etc., also have been noted to vary from one material manufacturer to another.

The industry needs first of all to unify the

methods of obtaining various physical data on plastic materials and, in so doing, develop test methods that will give data that is more indicative of the characteristics of the material from a processing standpoint. For example, no present physical test gives any indication of the weldability of a thermaplastic; in other words, the relative strength of the material through a weld or flow line.

On the basis of present test methods, some materials would appear to have very desirable physical properties for a given application, yet may also have very poor flow or weldabiity characteristics. In actual practice, the weldability factor of any thermoplastic is an important one.

A test to indicate this property should and can easily be devised by merely gating both ends of the test specimen instead of only one end. Thus, in tensile testing, the maximum tensile factor can be determined by testing the one-end gated specimen, while the relative strength of the material through a weld line can be obtained by tensile testing the two-end gated specimen.

Of no less importance is another need that is becoming more and more evident; that of an industry standard on plastic materials.

Many formulas of basic materials are offered by each materials manufacturer. For example, most styrene manufacturers offer a general-purpose formula, an easy-flow formula, a fast-set formula, a medium heat-resistant formula, and a high heat-resistant formula. Having these different formulas to choose from has been beneficial to the end-product, the molder, and the industry. The point is, however, do we need a half-dozen variations of each formulation of each basic material? Whether we do or do not, the real need is for an industry standardization of materials on a numeral index system basis.

The SAE numeral index system for steel composition is a good example. An SAE 2330 steel, for instance, is industry-wide understood to be a (2) nickel steel, (3) approximate percent of nickel alloy, and (30) average carbon content in hundredths of a percent. A PMS (Plastic Material Standard) classification could work the same way. The first digit indicating basic class of material; the second digit, the group or formulation; the third digit, the degree of modification explanatory of the second digit; and the fourth digit, the flow or melt index (moldability).

It is obvious that a four-digit number cannot by any means give anything but basic information. However, if all material suppliers classified various materials on a unified basis, the molder would soon become familiar with the nature of each formulation in a specified category.

The need for the establishment of such a system is plain, and the longer we wait, the more difficult it will become. The first comment with regard to such standardization has been "the material suppliers will not go along with it!" Actually, this assumes that material suppliers would have to change formulations in order to meet a PMS standard. This is not necessarily so, since existing formulations could be classified as is. The really important factor is that the industry would then be able to offer a processor, designer, engineer, etc., a Plastic Material Standard with a description of each numerical index group. From this standard, a designer could specify a PMS-number styrene, for example, to satisfy his application, rather than merely specifying a "heat-resistant styrene."

The plastics industry had its pains when we had too few materials to choose from and misapplications resulted. Now, with more and more materials and formulations to choose from, there is introduced a new factor—not misapplication but misunderstanding. The consumer will not understand why some products fail and others of seemingly a like material perform satisfactorily. The consumer cannot see or feel any appreciable differences in a basic material. For example, there are cases when a manufacturer specifies a non-nylon material in a color to match natural nylon with the specific intention of having the purchaser assume that the product or component is nylon based on his ability to distinguish nylon mainly by its "natural" color.

While numeral index classification of materials is most important within the industry, it will also benefit the consumer directly. There are several good ways of informing the purchaser of what to expect from a plastic article.

(1) Material suppliers' advertising in consumer magazines should give do's and don'ts of usage, cleaning instructions, etc., and emphasize the trade name, with mention of the basic class of material and direct attention to the PMS number.

(2) Labels on products—labels should include in condensed form the do's and don'ts, material trade name, generic name, and PMS number. (This along with advertising by material suppliers is the best approach by far.)

(3) All products which cannot be labeled and cannot carry the material trade name should show the PMS number by which the consumer would learn in time to associate a certain performance of product with a PMS number.

This is written with the hope that *some* form of plastic material classification will be instigated and put into effect. The purpose here is to emphasize the need.

—The End

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Preparation, Properties, and Applications of Isocyanate Products

A detailed discussion of formulations, properties, and uses of isocyanate foams, rubbers, lacquers, adhesives, and plastics.

In a recent article (1)*, one of the authors described the reactions of the isocyanates from a chemical point of view. This article discusses practical applications of these reactions in the fields of foams, rubbers, coatings, adhesives, and plastics.

Foams

To date, the exploitability of polyisocyanates for the formation of flexible and rigid foams has received the most attention from a commercial standpoint. The ability of these materials to be foamed in place, coupled with the asset of a choice of closed or open cell structure formation, are the two major reasons for this acceptance.

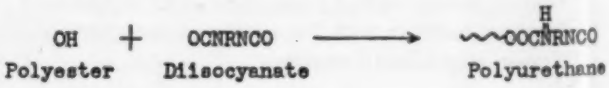
It seems advisable to review the mechanisms of isocyanate foam formation. Basically, the recipe for an isocyanate foam involves a high hydroxyl, low acid number polyester; a molar excess of at least a difunctional isocyanate; a catalyst; and water. The reaction of (NCO) groups of the isocyanate compound with (OH) and (COOH) groups is accelerated by the catalyst.

As shown in Equation I, reaction of (NCO) with (COOH) yields an amide and involves the evolution of carbon dioxide which contributes in a minor part to cell formation.

I

As shown in Equation II, reaction of the molar excess of polyisocyanate with the (OH) groups results in a chain-lengthened polyester possessing terminal (NCO) groups.

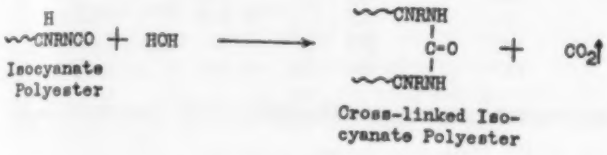
II



* Numbers in parentheses refer to bibliography at end of article.

As shown in Equation III, it is the reaction of H_2O with these isocyanate-extended polyesters containing terminal (NCO) groups that results in the simultaneous cross-linking of the polymer and evolution of the carbon dioxide necessary for cell formation.

III



Obviously, the composition of the original polyester, the quantity of polyisocyanate, and the concentration of water all are important factors which influence the physical properties of resultant foams.

Basically, foam production may be divided into two separate and distinct classes, rigid and flexible. At the present time, rigid foam production predominates commercially. When rigid foams are desired, a polyester having many points of branching and relatively low molecular weight is generally used. This is accomplished by incorporating trifunctional materials in the polyester.

A tabulation of the compositions of the various polyisocyanates and polyesters mentioned in this article and their trade names is given in Table 1.

Table 1. Compositions and Trade Names of Various Polyisocyanates and Polyesters

Composition	Trade Names
2,4-Tolylene diisocyanate.	Hylene* T, TDI.
Mixture of above with 2,6-Isomer.	Hylene TM, TDI mixed isomers, Desmodur R, Mondur** TD.
Dimerized TDI.	Hylene TD, TDI Dimer, Desmodur TT.
Hexamethylene diisocyanate.	Desmodur H, Mondur, HX.
Triphenylmethane triisocyanate.	TTI, Desmodur R, Mondur TM.
Reaction product of three moles TDI with one mole of Hexane Triol.	Desmodur TH, Mondur C.
Reaction product of three moles of hexamethylene diisocyanate with one mole of Hexane Triol.	Desmodur HH.
Reaction product of 25 moles adipic acid, 0.5 mole phthalic acid, and four moles of Hexane Triol.	Desmophen 800.
Reaction product of three moles adipic acid with four moles Hexane Triol.	Desmophen 900.

Rigid Foams

Two major aircraft companies have led the domestic field in commercial use of rigid isocyanate foams. Lockheed Aircraft currently holds several patents on isocyanate foam production. The actual use of foamed-in-place materials is in sandwich-type constructions such as wing and tail assemblies. These assemblies reportedly possess many advantages over the conventional sandwich types incorporating balsa or corrugated paper from the standpoints of ease of construction and ultimate performance of the finished parts.

Goodyear Aircraft has conducted extensive research in the field of foams for use in radomes; i.e., the housings of aircraft radar units. This research resolved itself into a basic specification for the individual components of a foaming recipe, and minimum performance ratings on the radome assembly.

This Goodyear specification calls for TDI of 98% minimum purity, and having an amine equivalent of 87-89 and a maximum hydrolyzable chloride content of 0.05%. The alkyd (polyester) portion of the specification requires that the alkyd be prepared from 7.6 moles of glycerol, five moles of adipic acid, and one mole of phthalic anhydride. The alkyd-polyester is condensed to an acid number of 40-46, a hydroxyl number of 475±6%, and a water content of 0.6-1.0%. Commercial resins reportedly meeting this specification are Selectron 5922 and PFR-1.

A typical formulation for foam production would consist of a given quantity of an alkyd polyester, such as Selectron 5922; a 10% molar excess over that amount of TDI which is theoretically required; a tertiary amine catalyst; water; and a surface-active agent. The alkyd, TDI, and catalyst would be charged and agitated in a refrigerated container, keeping exposure to atmospheric moisture at a minimum.

After stirring for 25-30 minutes, a creamy, opaque stage is reached. At this time, a given quantity of an acetone solution of a surface-active agent, such as Aerosol OT, is added. Stirring is continued for a short time, after which a noticeable decrease in viscosity takes place. The fluid mixture is then poured into a female mold which is tipped on a slight angle from the horizontal and allowed to stand for a short time to facilitate removal of occluded air bubbles. The male mold is then lowered into place, and the top placed on the mold.

The curing cycle for this foam is one hour at 71° C., followed by three hours at 135° C. The properties of a foam of this type were reported by B. D. Raffel of Goodyear Aircraft Corp. in May 1953, and are summarized in Table 2.

Table 2. Properties of Goodyear Aircraft Corp. Foam

Density of core, lbs./cu. ft.	10*
Flat-wise tensile strength at 25° C., psi.	250*
Flat-wise compressive strength at 25° C., psi.	300-400*
Heat distortion temperature of core, °C.	135*
Shear strength at 25° C., psi.	175*
Dielectric constant of core at X band	1.20
Loss tangent at X band	0.003
Thermoconductivity	0.4
Impact strength (falling ball), ft., lbs.	1

*Value declines 12-19% at 77° C.

The government specification called for the following properties of the foamed core: the cell structure of the

*Trade mark of E. I. du Pont de Nemours & Co., Inc.
**Trade mark of Mobay Chemical Co.

Table 3. Effect of Polyester Resin Acid Number on Foam Properties

Resin Acid No.	Softening Point, ° C.	Foam Density, lbs./cu. ft.	Tensile, psi.		Compression, psi.	
			25° C.	77° C.	25° C.	77° C.
44	125	6.95	134	103	185	144
26.5	126	8.55	200	151	236	190
22.1	125	8.58	225	172	262	199
13.8	117	9.67	272	205	307	239
8.36	119	11.6	327	280	444	306

cured resin was to be of the closed type, with an average diameter of 0.02 inch, and blow holes could not exceed 5% of the total foam volume. The figure presented by Raffel showed that the tentative specification had been met or surpassed by the Goodyear development in all performance characteristics but one; the maximum loss in mechanical properties at 77° C. was specified as 10%.

It is believed that a discussion of the factors which influence the behavior of a given foam recipe is necessary to more fully understand the effects of these variables on the uniformity and density of the foam.

Polyester Resin. As can be seen from Table 3, the acid number of the polyester resin has an effect on the foam properties. Foams made from the low acid number resins have adequate tensile and compressive strengths, but their softening points are lower than desired. Another point worthy of note is the effect of acid number on the density of the cured resin. Inasmuch as the free carboxyl content of the alkyd resin is partially instrumental in generating the carbon dioxide necessary for cell formation, the acid number of the polyester must be controlled to accurately predict the density of the resultant foam.

Polyisocyanate. The polyisocyanate normally is 2,4-tolylene diisocyanate or a mixture of this material with its isomer, 2,6-IDI. To obtain a desired end-product, it is necessary to have a complete knowledge of the composition of the polyisocyanate in order to maintain the proper stoichiometric balance between polyisocyanate, polyester, and water.

Water Content. The effects of varying water contents of the alkyd have been studied. Table 4 shows the effects of changes in acid number and water content of a specified type of alkyd on resultant foam properties.

Table 4. Effect of Alkyd Water Content on Foam Density

Water Content,%	Acid No.	Foam Density, Lbs./Cu. Ft.	
		Without AOT*	With AOT*
0.26	24	30	12
0.33	41	22	10
0.44	41	17	8
0.63	40	15	7
0.96	43	10	5
1.84	46	7.5	5**

* Aerosol OT solution surface-active agent.
** Reaction was so violent that much gas was lost.

This table shows that water can be added to an alkyd to a desired water content, and foam density can be varied greatly by minor changes in total water content. This permits the formation of foams from one basic alkyd that exhibit a wide range of densities.

One of the problems encountered in this work was the deleterious effect of humidity on foaming because of absorption of atmospheric moisture. To illustrate this point, a sample of polyester was stirred for 52 minutes at a relative humidity of 41%. During this time, the water content of the alkyd rose from 0.8-1.84%. As can be seen from the data in Table 4, this rise in water content could change the ultimate foam density by more than 100%.

Surface-active Agent. From Table 4 it is seen that there is a marked effect on foam density obtained by the use of Aerosol OT Solution. This component is used in the foaming recipe because it permits uniform foam production with minor variations in alkyd composition.

The basic foaming recipe was so adjusted that there was only a small difference between the amount of gas evolved and that required to produce a foam of desired density. This was achieved by regulating the water and carboxyl contents of the alkyd. With these contents in a desired range, however, the foaming rate was reduced and gelation often occurred before the desired expansion was reached. The use of Aerosol OT Solution gave a rapid rise of foam while the mix was still fluid.

In addition to obviating any minor variations in the alkyd resin portion of the recipe, the use of the Aerosol OT Solution resulted in a marked decrease in viscosity of the reaction product which facilitated removal of all occluded air and, in turn, eliminated blow holes and irregularities in the foam.

Advantages of Isocyanate Foams. The simplicity of producing an isocyanate foam from manufacturers' ingredients is a distinct advantage. This operation is in contrast to the high temperature, pressure, and expensive equipment required to cure most other types of foams. To summarize, the distinctive advantages of isocyanate foams are reported to be the following:

(a) Can be foamed in place, avoiding shaping, fitting, and transfer of the finished piece.
(b) Can be adapted to provide adhesion to the surface of the cavity wherein it is made.
(c) Variations in density from 3-25 pounds per cubic foot are available to the formulator.
(d) Foam bubbles are discontinuous.
(e) Any degree of rigidity or flexibility may be

obtained by proper choice of the reactants.

(f) The foam may be filled with certain inert materials, such as siliceous pigments or clays, to get various alterations of properties.

(g) The electrical properties of the isocyanate foams render them worthy of consideration in electrical and electronic applications.

(h) Good thermal insulation properties.

(i) Resistance to water.

These properties have led to the use of rigid isocyanate foams on a commercial or semi-commercial level for protection of radar equipment; contributing strength to intricate spaces with the addition of little weight (such as aerilons for wing tips of aircraft); filling of voids in installed process equipment to exclude moisture or other objectionable substances; thermal insulation; buoyant fillers for small seacraft; and protective filler against shock and moisture for electronic equipment.

Flexible Foams

At the present time, there is considerable controversy with respect to the advantages offered by isocyanate flexible foams in comparison to competitive foams from vinyls and natural rubber with regard to performance characteristics and relative costs. One factor which may weigh heavily in favor of isocyanate foams is the existing licensing arrangement by Elastomer Chemical Corp. governing the production of the competitive foams. This company holds patents covering the mechanical, rather than chemical, process for making flexible foam from liquid vinyl.

In the field of flexible plastic foams, Elastomer claims 85% of the market for its licenses: United States Rubber Co., Goodyear Tire & Rubber Co., Firestone Tire & Rubber Co., B. F. Goodrich Co., Nopco Chemical Co., Congoleum-Nairn, L. E. Carpenter & Co., and others. It is believed that these patents are applicable until 1966. In contrast, the various patents governing the manufacture of polyurethane foams reportedly expire in 1959. The degree of influence of this disparity in the tenures of these patents on the leanings of American industry is a matter of conjecture at the present time.

Basically, the chemical reactions involved in flexible foam formulation are identical to those of rigid foams (see Figure 1). The major point of difference in formulating for flexible foams is the composition of polyester. For flexible foams, the use of polyesters which are essentially linear and have molecular weights in the order of 1,500-2,500 has been the reported practice in Germany. It has been reported that the current use is of polyesters possessing low acid numbers in contrast to the higher ones previously used, based on the observation that the degree of foaming could be controlled much better by regulating water content of the foaming formulation than by adjusting the acid number of the polyester portion.

From the developments in flexible isocyanate foams on the American scene, it appears that the preparation of pre-polymers will be the accepted method of placing basic raw materials of a foaming recipe in the hands of a fabricator. This approach involves the preparation of the reaction product of a suitable polyester with an excess of a polyisocyanate compound.

The development of these pre-polymers has been described as a major advance in foaming technology. They are reportedly easier to handle, so that the mechanical production of foams is easier to control. In addition, the fabricator need not maintain a suitable technical staff to control the previously relatively complicated procedure. From the standpoint of preparation, the rigid controls necessary for polyester production have been taken from the ill-equipped handle of the fabricator and more sensibly returned to the basic manufacturers of compounds of this type.

The major problem in use of pre-polymers is the special handling precautions they require because of their tendency to gel as a result of reaction with atmospheric moisture. Although a strong negative, this factor would seem to be overweighted by the many advantages of this method.

Flexible foams of normal production have averaged approximately 80% closed and 20% open cell structure. Again, this ratio may be changed by variations in the reactants and their ratios of use. Some foams possessing almost entirely open cell structure have been made, and have proved especially useful for sound insulation and seat cushioning. The resilient or flexible

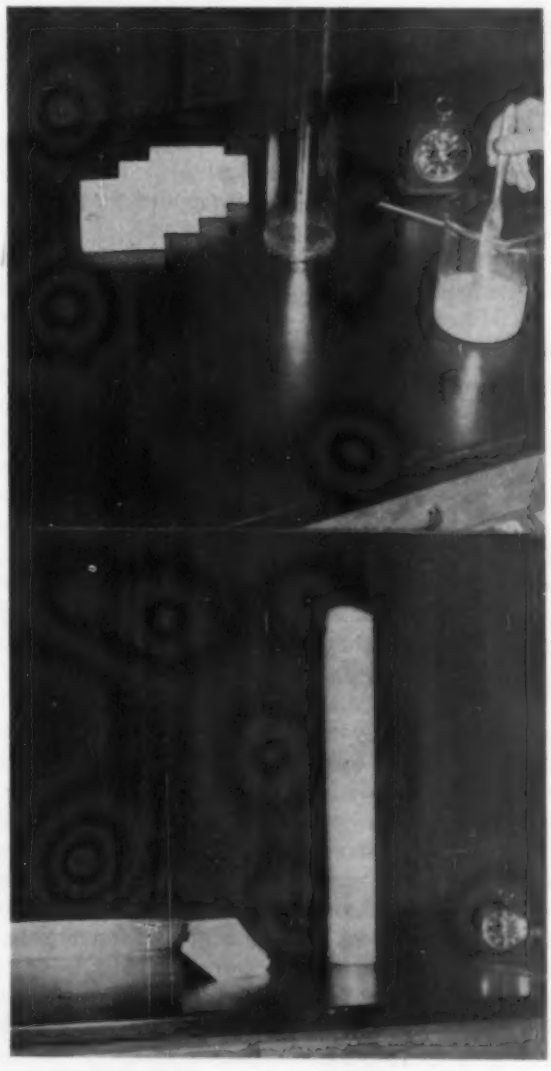


Fig. 1. Two steps in the process of preparing a flexible isocyanate foam.

Table 5. Effects of Polyurethane Rubber Components

Glycol	Acid	Tensile, Kg./Sq. Cm.	Elongation, %	Remarks
Ethylene	Succinic	273	625	Hard, leathery.
	Adipic	350	640	Slowly hardens.
	Sebacic	—	—	Hardens immediately.
	Diglycolic	270	570	Leathery.
	Phthalic	107	261	Glass-hard without softener.
1,2-Propylene	Succinic	180	670	Leathery.
	Adipic	220	780	Does not harden.
1,3-Butylene	Adipic	179	630	Does not harden.

foams have been found to be functional in the temperature range of −20 to ±130° C.

Rubbers

In this country, the most immediate large-scale, non-foam use of diisocyanates that will come to the public's attention is undoubtedly in the manufacture of rubbers. It is expected that limited quantities of these rubbers will be available to the public within a year.

Historically, the Germans were in the forefront of exploiting the condensation products of glycol polyesters and the diisocyanates as rubber-like materials (polyurethane rubbers). Goodyear Tire & Rubber Co., the first United States firm to announce the availability of a polyurethane rubber (Chemigum SL), has admitted that their first practical help leading to this development was obtained from the work of Otto Bayer in Germany.

Du Pont recently announced the availability of its polyurethane rubber, Adiprene B. With this material, believed to be a reaction product of an adipic polyester with a polyisocyanate, the use of Hylene DMM (4,4′-methylenedi-o-tolylisocyanate) or Hylene TU (two moles TDI plus urea) as the preferred vulcanizing agent is suggested.

In simple terms, the formation of the raw gum involves two steps: (1) the formation of a linear polyester with an excess of glycol; and (2) the chain extension of this polyester with diisocyanate. Finally, cross-linking of this gum to the finished rubber product is accomplished by adding additional polyisocyanate or isocyanate in combination with either a glycol or a diamine.

Again, as is often the case with polyester isocyanate products, the final properties of the finished product are dependent on the components therein. Table 5 shows the effects of some of these components.

Because of their greatly increased resistance to abrasion and the improvements they offer in oil resistance, cut-growth resistance, general weathering resistance, the low oxygen absorption shown by these polymers, and the low internal friction of properly-compounded stock, these urethane rubbers are expected to find important use in the field of tire capping. The so-called 100,000-mile tire may prove to be a polyurethane rubber capping on a more conventional carcass.

While the above advantages justify their use, the limitations of polyurethane rubbers seem to be their poor resistance to high temperatures, hot water, and steam; the limited storage life of milled stocks (requiring additional supervision and superior plant procedures); and hardening at low temperatures. Recent traction tests have indicated the suitability of polyurethane rubbers on ice, but their inferiority at the present state of development to cold GR-S and natural rubber on both wet and dry pavements.

While it would be impossible to predict all the final uses of the polyurethane rubbers, exploratory investigations have shown their suitability for solid tires, soles and heels, and conveyor belt surfaces. Again, dependent on their superior abrasion resistance, their use as flooring materials can be expected, as well as protective coatings for rubber, plastics, and fabrics. With the high impetus soon to be given these rubbers by several companies, their rapid exploitation in a myriad of uses seems to be a foregone conclusion. Some present forms and applications of Goodyear's Chemigum SL are shown in Figure 2.

Lacquers

The application of diisocyanates in the formation of lacquers is probably best discussed by their use in German practice, since lacquer applications to date in this country have been minor, if at all. Basically, an isocyanate lacquer is prepared by dissolving a suitable polyalcohol and a polyisocyanate in a 4:3 ratio in suitable inert solvents. The addition of pigments or other lacquer modifiers to this combination is possible.

When made, the lacquer solution is normally applied by spraying, and can be dried either at room temperature or heated to 160° C. The lacquer coating thus formed is reported to become completely insoluble and infusible.

A typical wood lacquer would be prepared in German practice by dissolving 40 parts of Desmophen 1100 (a polyester made by reacting three moles of adipic acid, two moles of a triol, and three moles of butylene glycol) in 60 parts of a solvent blend containing equal parts of ethyl acetate, butyl acetate, and toluene. This solution is mixed with 90 parts of Desmodur TH (a reaction production of three moles of TDI with one mole of Hexane Triol) in 50% solution in equal parts of ethyl acetate and toluene. This lacquer is dry to the touch after about three hours, and completely hard in 4-5 days.

While this is a typical example, there are several important generalizations that can be made relative to the

influences of the lacquer components on the final properties. These generalizations are as follows:

(1) The higher the ratio of polyalcohol to di-acid in the polyester, the harder the final film.
(2) Conversely, the lower the ratio of polyalcohol to di-acid, the softer the film.
(3) The greater the degree of cross-linking, the harder and more brittle the film.
(4) The higher the concentration of aromatic components in the lacquer, the harder the film.

While the United States has been slow to exploit the properties obtained with diisocyanate lacquers, it has been observed that properly formulated and applied lacquers show such properties and advantages as excellent adhesion to many substrata; good gloss; a high degree of impermeability; excellent water resistance; good electrical resistance; good weatherproofness; and outstanding solvent resistance. In addition, they can be applied at temperatures ranging down to normal room temperatures, and at considerably higher solids contents than conventional nitrocellulose lacquers.

It would be unfair to gloss over their disadvantages which include higher price (although the current increased production in the United States of the essential components of these materials may help bring this into line); poor pot life (generally less than one day, although techniques are available where this can be increased to several days through the choice of slower-reacting diisocyanates and the elimination of catalysts); and difficulty in cleaning up after application due to the progressive insolubilization of the lacquer.

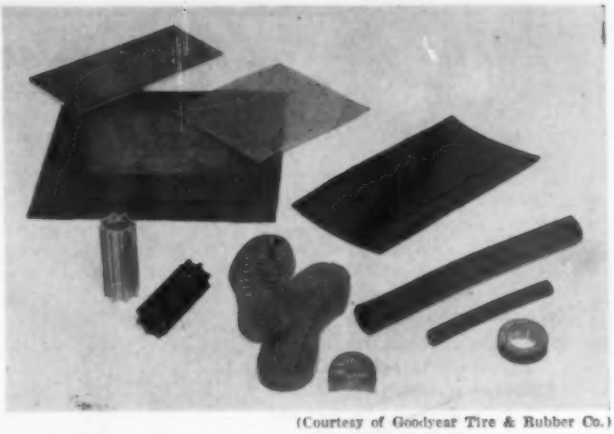
Recent techniques in baking-type finishes involves the use of "isocyanate generators." These materials in a lacquer formulation give a one-package system that can be converted to coatings that are highly resistant to chemicals and solvents when properly baked.

These new lacquers have been found to be excellent as weatherproofings for wood and textiles, corrosion-resistant coatings for light metals, and as impregnants for cardboard and armature windings. Future applications are seen for their use as coatings for ships, in the manufacture of patent leather, and the treatment of textiles.

Adhesives

It is in the field of adhesives that the use of polyisocyanate-type materials has been the most successful in domestic industry. Here, their primary use has been as additives in elastomeric cements made from natural rubber, neoprene, GR-S, or nitrile rubber. However, the Germans exploited the isocyanates as additives for polyesters, and used them for bonding a greater variety of materials than is common here.

It was the German claim that these materials would stick "anything to anything." German practice resulted in materials that were used successfully in bonding metal to metal, metal to glass, metal to plastic, wood to wood, etc. In the United States, the greatest exploitation of these adhesives appears to be in the bonding of rubber to metal, ceramics to metal, and rubber to synthetic fibers such as are used in the manufacture of tires.



(Courtesy of Goodyear Tire & Rubber Co.)

Fig. 2. Typical forms and finished products of Goodyear's polyurethane rubber, Chemigum SL.

Based on German practice, three methods of bonding with polyurethane adhesives are worthy of mention: (1) low-temperature bonding where heat-sensitive materials generally are involved; (2) high-temperature bonding where materials such as metals are the adherends; and (3) the carrier method where adhesive is deposited on a material such as a metal foil and allowed to cure before being reactivated by heat and pressure.

In low-temperature bonding, the reaction is triggered by the use of a tertiary amine catalyst such as n-methyl morpholine. In practice, the isocyanate-polyhydroxy compound containing the catalyst is applied as a thin film of solvent solution to both surfaces and exposed to the air for a short period of time to allow atmospheric moisture to aid the cure. The bond is made by contact pressure, and complete curing can be exposed in 8-24 hours. It should be noted that strong bases, such as alkali metal hydroxides, cause violent exothermic reactions when used as bases, and are not recommended.

The high-temperature bonding system has definite advantages, such as the need for coating only one surface, a greater choice of adhesives, a very rapid cure, and a generally higher order of bond strength. In this system, the adhesive is allowed an open cure before being heated to 150-300° C. under sufficient pressure to attain intimate contact. Cooling results in a cured system.

With the carrier method, a convenient system of bonding results. The carrier, be it aluminum, copper, or lead foil, or a tissue-paper cellulosic, is dipped into a thin solution of the adhesive and allowed exposure to atmospheric conditions or steam until cured. The carrier can then be used by placing it between adherends and applying heat and pressure to melt the adhesive, or stored between waxpaper or other interleavenings for use at a later date.

With the wide variety of commercial polyhydroxy materials available, ranging from one of the simplest, 1,3-propylene glycol, through the polyethylene glycol to such products as polyesters and castor oil, it is evident that an almost endless number of compounds could be made from the more than half-dozen commercially available polyisocyanates. Adhesives tailored to meet specific needs can be expected. Shear strengths in excess

Table 6. Comparison of Properties of Igamids U, A, and B

	Igamid U (Polyurethane)	Igamid A (Nylon Polyamide)	Igamid B (Polycaprolactam)
Specific gravity	1.21	1.14	1.15
Approx. melting point, ° C.	183	255	210
Brinnell hardness, kg./sq. cm.	750	1,000	600
Flow temperature, ° C.	170-180	220-225	160-180
Impact strength, cm. kg./sq. cm.	Approx. 100	>100	—
Unoriented material:			
Tensile strength, kg./sq. cm.	620	—	380
Resistance to cold, ° C.	+8	—	+13
Oriented material:			
Tensile strength, kg./sq. cm.:			
Lengthwise	874	—	1,050
Transverse	400	—	860
Elongation, %:			
Lengthwise	60	—	73
Transverse	81	—	70
Resistance to cold, ° C.	—30	—	—30

of 1,500 psi. have been reported on metal-to-metal bonds. Materials bonded successfully have included steel, aluminum, magnesium, glass, cellulose acetate, and acrylic sheet.

In Germany where the use of more complicated polyisocyanates were employed and where polyesters were used instead of polyhydroxy compounds, it was found that certain combinations gave significantly improved performance on certain substrata; i.e., particular combinations of polyisocyanates and polyesters were chosen whenever certain materials were to be bonded. The German name for some of these adhesives was Polystal, and it was customary to supply them as two-package systems having limited combined pot lives.

A typical wood-to-wood adhesive was a combination of Polystal U I and Polystal U II. The polyester component, Polystal U I, a 70% solution of Desmodur 900, was combined with 2-2½ parts of the polyisocyanates component, Polystal U II, a 75% solution of Desmodur HH. This mixture had a combined stability of 8-10 hours, and a setting time of 1-2 days. With the use of alkalies or a tertiary amine, the setting time could be reduced to three hours at normal room temperatures. Bond strengths of 1,000-2,000 psi. were reportedly obtained, depending on the substrata. The adhesive had the advantage of considerably higher resistance to heat and hot water than urea-formaldehyde adhesives, while not requiring the heat needed by the latter for good bonding. Phenolic resin adhesives for the same use were considered to produce excellent but brittle bonds, and required strong acids which were detrimental to the wood.

For a metal-to-porcelain adhesive, 10 parts of Desmophen 900 were reacted with six parts of Desmodur T. The adhesive required elevated temperatures for cure; about one hour at 170° C. Tear tests always resulted in failure of the substrata.

A successful metal-to-metal or metal-to-glass adhesive was made by combining two parts of a 75% solution of Desmophen 800 in ethyl acetate with 0.5 part of hexamethylene diisocyanate. This combination was suitable for only six hours, but gave steel-to-steel bonds having a strength of 250 kg./sq. cm. at 20° C., and 100 kg./sq. cm. at 80° C.

These adhesives are normally applied to one (or both, if desired) of the roughened surfaces and allowed to dry for 10-15 minutes before the surfaces are firmly clamped together, but not so firmly as to squeeze out all the adhesive. Approximately ⅔-ounce of adhesive is applied per square foot of bonded area.

Common domestic practice is the manufacture of cements from an elastomer in a solvent to which a polyisocyanate is added. Alternately, the polyisocyanate can be applied to one or both of the surfaces to be bonded as a solution in an organic solvent, force dried, and then combined with an elastomeric cement containing no isocyanate. The order of adhesion quite often is 4-5 times that of a similar cement not involving polyisocyanate, and often represents a very functional bond as compared with one that would be unusable. These cements are two-package systems due either to gelling of the solution or reduced effectiveness of the isocyanate as an adhesion promoter with the passage of time. Studies have indicated that solvent selection affects cement stability, drying speed, toxicity, and flammability.

The isocyanates currently are enjoying wide use in Europe as additives to elastomeric cements. Shoe adhesives, metal-to-sponge adhesives, metal-to-weatherstripping adhesives, and others all are improved in performance by the simple addition of polyisocyanates to the base compound.

Plastics

The polyisocyanates also are useful in the field of plastic materials. Polyurethanes made by the addition polymerization of diisocyanates and glycols are marketed in Europe, especially in Germany, as Igamid U. A comparison of this material with two other Igamid plastics is given in Table 6.

(*Continued on page 178*)

Fabric Coating Techniques*

A review of coating methods for making plastic-coated fabrics, with information on selection of base fabrics and coating compounds.

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In 1955, the coated fabric industry sold enough material to encircle the globe three times. Some 120,000,000 yards, valued at more than $100,000,000 were produced for a variety of end-uses. The highly styled and colorful upholstery and trim in automobiles, the upholstery on the comfortable occasional chairs in living rooms, and the book-binding on reference books are just a few of the end-uses. In this paper, we will discuss the materials and techniques used in manufacturing these plastic-coated fabrics.

The Base Fabric

Proper selection of the base fabric is the first step in the construction of a sound coated fabric. Tensile strength, tear strength, cost, weight, appearance, and flammability are factors that must be considered. The base fabrics used can be classified into three broad groups:

(1) Woven: Cotton, rayon, nylon, and glass.
(2) Knitted: Cotton and rayon.
(3) Non-woven: Cotton, rayon, or nylon fibers bonded with elastomeric materials. Binder can be either cured or uncured.

The fabrics or fibers may be untreated, or may be bleached and/or dyed before the coating operation.

The woven fabrics, especially cotton, account for the greatest yardage, but there is an increasing trend toward greater use of knitted and non-woven backings for upholstery applications. Coated fabrics of this type can be tailored easily because of their high elongation.

A most interesting new development of Textileather is a vinyl calendered on non-woven backing. This backing consists of nylon and rayon fibers bonded with a cured synthetic rubber. This construction has equal stretch in all directions. The random fiber distribution contributes an extremely high resistance to tear and eliminates clothiness on the lighter weight coatings. The fabric lends itself to modern styling and, above all, is attractively priced. Other coaters in this country and abroad are being licensed to produce this type of coated fabric.

The Coating Compound

The second step in the manufacture of a coated fabric is the choice of coating compound. Our remarks in this paper will be confined to a discussion of pyroxylin and vinyl coatings. While vinyl-coated fabrics have found widespread use wherever superior flexing and abrasion resistance are required, millions of yards of pyroxylin-coated fabrics are used annually for book-binding applications. Generally speaking, use of pyroxylin is confined to woven fabrics, while the vinyls can be used with all fabrics.

Figures 1 and 2 show a comparison of vinyl- and pyroxylin-coated fabrics (24-ounce finished weight) with regard to flex and abrasion resistance, respectively.

*Based on a paper presented at the twelfth annual National Technical Conference, Society of Plastics Engineers, Inc., Cleveland, Ohio, Jan. 19, 1956.

Coating Methods

Various methods are used for applying the plastic coating to the base fabric. In widest use are the knife coating (see Figure 3) and the reverse roll coating (see Figure 4) methods.

A typical pyroxylin coating consists of a mixture of 15-20 sec. n/c, pigment, castor oil, and solvent. The solids content for knife coating is 40-45% while roller coating uses 20-25% solids content.

Vinyl coatings for the aforementioned coating methods may be applied either in solution form or as dispersions. The bulk of vinyl coatings applied by either knife or reverse roll are dispersion coatings. The dispersion may be in the form of an organosol, plastisol, or latex. A typical vinyl dispersion consists of a mixture of vinyl resin, plasticizer, pigment, stabilizer, filler, and diluent (water in the case of latex coatings). Organosol coatings require ball-mill mixing for 16-24 hours. Colors, in the form of pigment ground in plasticizer, are generally added to a base clear. Organosol solids are in the range of 60-85%. Because of the ease of mixing and the higher solids obtainable, plastisol coatings have replaced organosol coatings for many applications. A typical plastisol may be mixed on a pony mixer, then may be strained and/or run through a three-roll paint mill.

Control of flow properties is essential for efficient plant operation with a minimum of rejects. Since vinyl dispersion coatings are applied at speeds ranging from 20-50 yards per minute, it is important to have some means for evaluating and measuring flow at high rates of shear. The extrusion rheometer is a valuable tool for determining proper viscosity and flow properties for high speed coating operations.

Some interesting data obtained with the extrusion rheometer are contained in Figures 5 and 6. Figure 5 shows the flow properties of a group of plastisol resins,

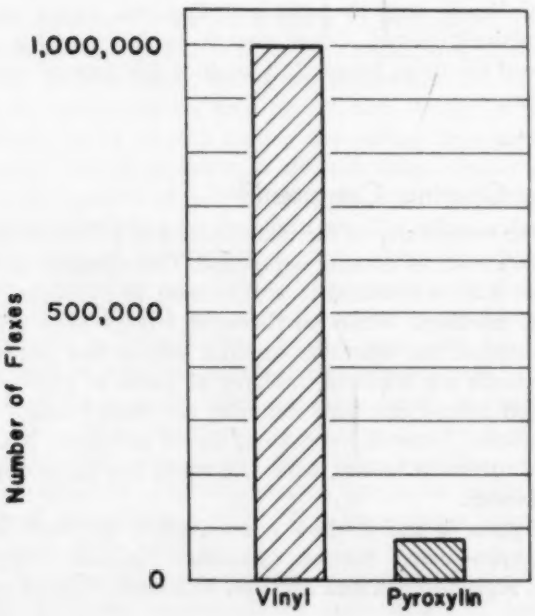

Fig. 1. Comparative flex resistance of vinyl and pyroxylin coated fabrics (24-ounce finished weight).

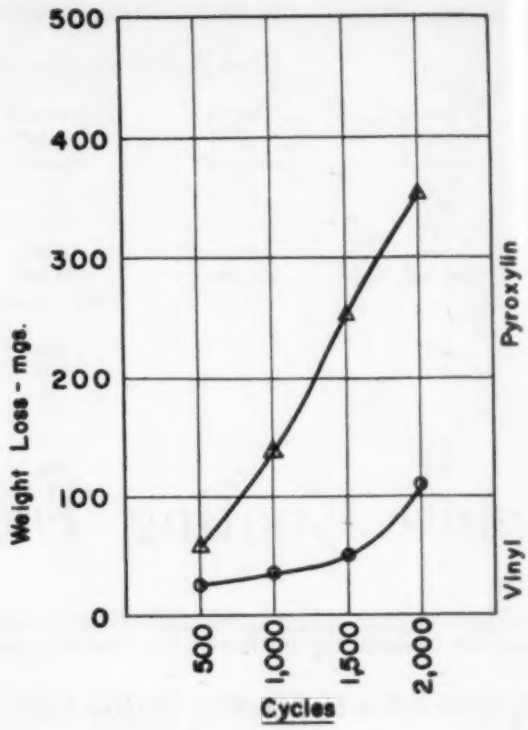

Fig. 2. Comparative abrasion resistances of vinyl and pyroxylin coated fabrics (24-ounce finished weight).

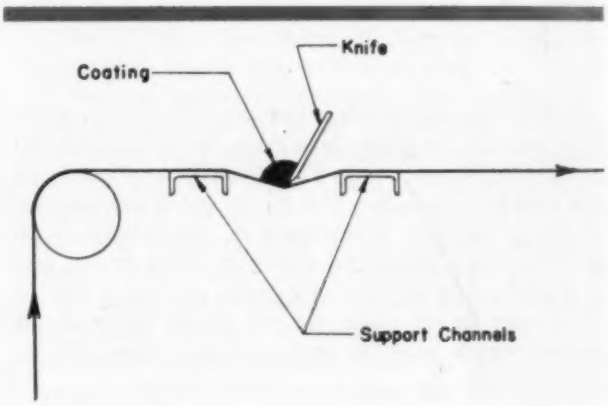

Fig. 3. Schematic view of knife coating.

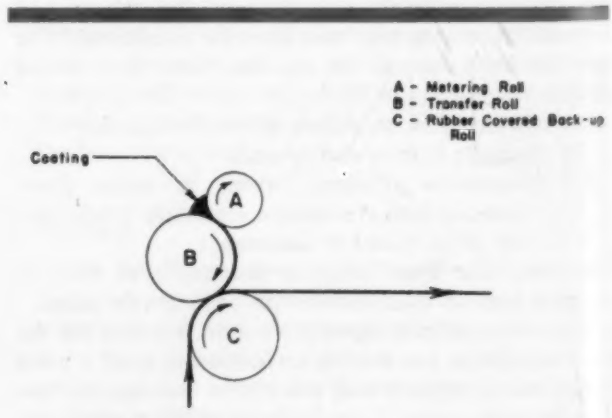

Fig. 4. Schematic view of reverse roll coating.

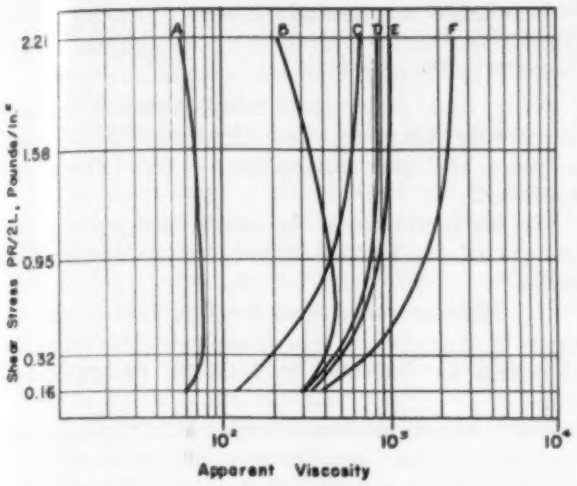

Fig. 5. Flow properties of typical plastisol coating resins.

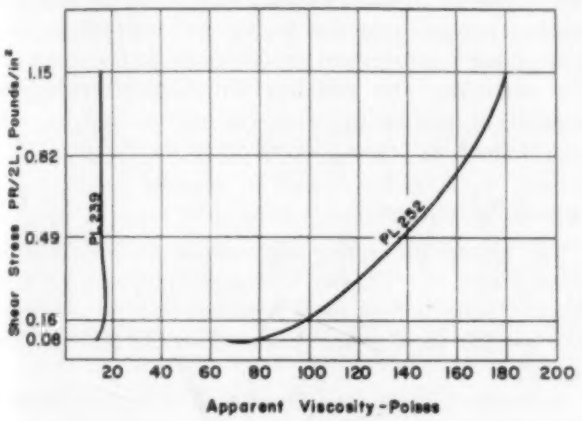

Fig. 6. Flow properties of two vinyl dispersions for coating.

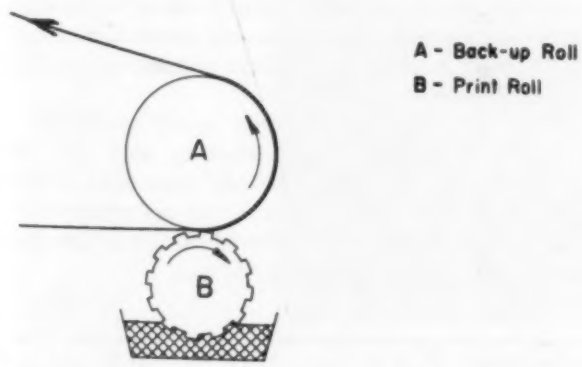

Fig. 7. Schematic view of rotogravure printing operation.

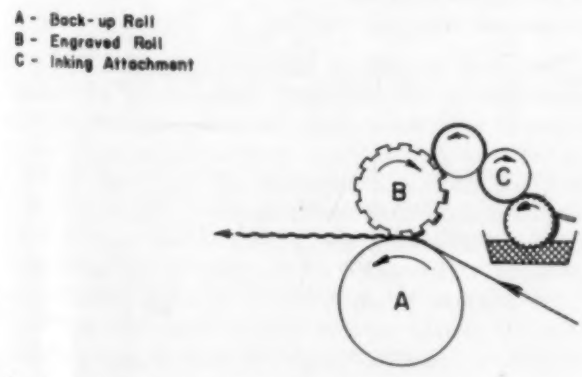

Fig. 8. Schematic view of ink embossing operation.

while Figure 6 shows the flow properties of two vinyl dispersions.

These formulations shown in Figure 6 are typical production types. One of these formulations, PL252, exhibited a phenomenon during coating which is referred to as spitting." When this occurs, heavy blobs of material leave the rear edge of the coating knife and result in unsightly lumps on the finished product. The other curve in Figure 6 represents a coating, PL239, which has given little or no trouble during actual coating operations. Dilatant formulations are most undesirable in coating, and design of the coating knife is an important factor.

After either the knife or roller coating operation, the goods are passed through an oven to evaporate the solvent and/or fuse the coating. Solvent evaporation for pyroxylin is done in steam-heated ovens at 180-225° F. Fusion of organosols and plastisols is accomplished either at 350-400° F. in gas- or oil-fired ovens, or with radiant or strip-type electrical heaters. Embossing may be done either in train with coating and fusion, or as a separate operation.

The lamination of vinyl films to fabrics is another popular vinyl-coating technique. There are two basic approaches; the dry and wet methods. In the dry method, the vinyl film is calendered on a four-roll calender, and laminated (with heat and pressure) to the fabric either at or beyond the calender. Special bond coats are sometimes used to improve adhesion to the base fabric.

In the wet laminating method, the vinyl film is applied by a reverse roll coater to either a metal belt or a special casting paper, and then fused at 350-400° F. The fabric can be laminated to the film at any point in the operation.

After the base coating operation, solvent printing inks or slip finishes may be applied, generally by rotogravure roll. Interesting effects also are obtained by the application of aqueous inks to the engraved surface of an embossing roll. As the pattern is impressed into the coating, the contrasting color is deposited in the valleys of the grain pattern. Figures 7 and 8 show the rotogravure printing and ink embossing operations, respectively.

Future Growth

The continued growth of the plastic-coated fabrics industry is dependent upon a number of factors, as follows:

(1) The ingenuity of the chemists, engineers, production men, and stylists within the industry itself.

(2) Continual education of the consumer and industrial user to prevent misapplication of the product.

(3) The maintenance of high-quality standards.

(4) The development of improved raw materials.

For this fourth factor, the industry is looking to the chemical supplier for such items as internally plasticized resins, permanent plasticizers with improved low-temperature resistance, and improved finishes to minimize surface tack.

—The End

A Ball Drop Technique for Estimating Polyethylene Film Toughness
(*Continued from page 157*)

changed, processing conditions also must be changed. Consequently, any change in toughness is not due to thickness alone. Preliminary indications are that orientation has a far greater effect on toughness than small differences in sample thickness.

Conclusions

The ball drop technique was investigated and carried through several stages of development. The many variables studied included specimen size, velocity of impact, diameter of impinging surface, and sample variation. A statistical method was developed which gave an effective measure of resistance to shock impact for thin film.

The procedure consists of dropping a dart from a fixed height onto the film mounted in a hoop and centered in a positioning frame. The dart is composed of a hemispherical phenolic base and an aluminum shaft with removable weights. After the weight range for break-through is established, the per cent failure in 10 samples is determined for each of four dart weights. Percent failure is then plotted against weight of dart. The slope of the straight line obtained, together with the weight at which 50% of the samples fail, clearly define film toughness under these conditions.

Reproducibility within and between operators was very good for a limited number of resins of different toughness levels. No correlation has been observed between uniaxial data and ball drop impact values. Thus, the method provides an independent measure of toughness, and should prove valuable as an evaluation technique for characterizing polyethylene resins and studying the effect of processing conditions on film quality.

Acknowledgment

Sincere thanks are due many members of Monsanto's plastics division for their interest and assistance throughout this development. Among them are R. J. Bourke, R. E. Cairns, and R. J. Schatz of the research department; P. Stahlberg, and M. A. Manganelli of the technical service staff; and E. C. Harrington of the statistics department. Also, appreciation is given Helen Lata, laboratory assistant in the research department, who obtained much of the experimental data.

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—THE END

Preheating Polyethylene and Impact Polystyrene Prior to Extrusion
(*Continued from page 165*)

(5) Physical properties of thin film made from moisture-sensitive compounds were improved. The physical properties of thicker sections, such as pipe or tape, were unaffected.

(6) No improvement in compounding (color dispersing) of dry blended resin-color mixtures was observed.

(7) Resins extruded from hot feed showed less tendency to degradation than those extruded from cold feed. This was indicated by a 5-10% change in melt index.

Results of tests made with both moisture-sensitive and normally dry resins indicated that the benefits were common for all grades of polyethylene, and the preheating advantages are not restricted to moisture-sensitive materials alone. In all cases, benefits varied directly with preheating temperature; the higher the temperature, the greater the improvement in extrusion performance. At low extrusion rates and low screw temperatures, the benefits of preheating were not as marked as with operation at high rates and hot screw conditions.

Impact Polystyrene

The highest preheating temperature for impact polystyrene was 85° C. and resulted in similar, but less marked, benefits than those obtained with polyethylene. The specific benefits are described in the body of this report.

In determining the benefits of preheating polyethylene and impact polystyrene, no compensating deleterious effects of preheating were found. From the benefits described above, preheating is determined to be a relatively simple method of increasing productive capacity which might otherwise be obtained only by increasing the size of the extruder.

While the benefits described apply specifically to extrusion, it is likely that preheating may also offer similar benefits in other forming operations such as injection molding and Banbury or roll mill compounding operations. Therefore, it is believed worthy of consideration in these fields of processing as well.

—THE END

Preparation, Properties and Applications of Isocyanate Products
(*Continued from page 174*)

The same product as Igamid U is called Perlon U when used in the fiber field. As presently formulated, Perlon U is prepared from 1,6-hexane diisocyanate and 1,4-butylene glycol. Since tremendous expenditures of time and money in research are involved before a product is considered marketable in the plastics or fiber fields, the following are general observations on the effects of variations in components in the isocyanate-glycol reaction product field that helped decide that Perlon U should have its present composition:

(1) Ethylene glycol cannot be used because it decomposes with gas solution.

(2) In general, glycols from 1,3-propylene glycol on up to the primary diols are suitable.
(3) Secondary hydroxy groups lower the melting point, increase the thermoplasticity, and decrease the thermo-stability.
(4) Tertiary hydroxyl groups cause decomposition at 170° C.
(5) Glycols containing odd numbers of CH_2 groups always have substantially lower melting points than do those with even numbers.
(6) Melting points generally decrease in any series as the number of carbon atoms in the glycol increases.
(7) Sid-chain polyurethanes increase the solubility and decrease the strength.
(8) Benzene rings increase brittleness and decrease the fiber-forming tendencies.
(9) The possibility of 1,4-butane diisocyanate replacing 1,6-hexane diisocyanate exists because it would give a 12° C. higher melting point (194° C.).

Toxicity

The subject of use of isocyanates in industry should not be concluded without some mention of their physiological action. Because of their reactivity, they can be expected to react with body tissues. All contacts with skin, eyes, and lungs should be avoided. They do possess toxic properties, although this varies with the particular product. The more volatile isocyanates are lachrymators and should be avoided by persons having a history of asthma. Some, such as diphenylmethane diisocyanates, are reported to be non-toxic.

Conclusions

The use of polyisocyanates is on the threshold of widespread commercial acceptance in the fields of foams. rubbers, coatings, adhesives, and plastics in this country. Despite the shortcomings of limited stability in many cases, variable toxicity, high cost, reactivity, and need for careful control, the ultimate products that result from intelligent exploitation of these materials justifies their use.

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—THE END

Cement-carrying trailers topped with reinforced plastic lids.

Reinforced Plastic Trailer Domes

Dome-shaped lids of fibrous glass-reinforced polyester resins have replaced the riveted aluminum lids used by Trailmobile, Inc., to cover dry cement in transit. About 50 of the firm's double-trailer diesel units have been equipped with the lids, which are moisture resistant and impervious to air and cement dust.

The three-foot high domes are eleven feet long by eight feet wide, and are molded in one piece using Vibrin polyester resin, a product of the Naugatuck Chemical division, United States Rubber Co., Naugatuck, Conn. Commercial Plastics Co., Santa Ana, Calif., produces the lightweight domes, which have seen over 50,000 miles of service without requiring repairs of any kind.

—THE END

News of the Societies

Walter J. A. Connor

Conference Chairman Named

Walter J. A. Connor, vice president and director of American Plastics Corp., has been named chairman of the technical conference on plastics, which will be held June 11-15, at the new Coliseum in New York City. The Conference will be held in conjunction with the Seventh National Plastics Exposition, sponsored by The Society of the Plastics Industry, Inc.

Plans for the Conference include technical papers and presentations on the use of plastics in such fields as the automotive, radio and television, transportation, packaging, textile, tooling, refrigeration, and furniture. Special attention will be paid to retail buyer needs and interests.

The Seventh National Plastics Exposition and Conference is expected to be the largest ever held by the plastics industry, and is designed to give representatives of industry an over-all look at this $1.8-billion field. Exhibitors currently registered for the Exposition include molders, laminators, extruders, fabricators, reinforced plastics manufacturers, raw material suppliers, machinery and equipment manufacturers, and tool, die, and mold makers. As an added feature, prizes will be awarded to architects, draftsmen, and architectural students for outstanding designs in the current SPI-sponsored plastics house competition.

Compares Molding Processes

Over 90 members and guests attended the February 15 meeting of SPE's New York Section, held jointly with the Section's Reinforced Plastics Group at the Gotham Hotel in New York City. The meeting took the form of a panel discussion comparing four molding processes with respect to their modes of manufacture, tooling required, and costs. Two items, a six by six-inch cone and an 18 by 24 by 12-inch box were chosen to illustrate the techniques in question.

Bud Ullman, Kuhn & Jacob Molding & Tool Co., was not too optimistic about the use of compression molding in either case. He felt the cone was definitely out. Cost would be the primary consideration here, since compression molding requires a large press and preformed material. Tooling could cost anywhere from $6-15,000 and, with a cycle time of six minutes, approximately 10 boxes could be turned out per hour. Even without considering rejects, and thermosetting material cannot be reused, Mr. Ullman estimated piece cost for a 1,000-unit run to be around $5.50. A 5,000-unit production would bring piece cost down to $5.25-5.35; however, mold amortization would necessitate extremely long runs to make compression molding competitive.

Injection molding was the method chosen by Saul Blitz of Tico Plastics. He also felt that the number of pieces was the primary factor in the case of the box. He estimated mold cost at $15,000, and brought up the question of delivery date—about 24 weeks. However, in 80 gage high-impact styrene, he estimated a unit cost of $2.11 ($4.00-6.00 for butyrate, assuming the same cycles). The six-inch cone presents little problem, since the standard injection press opens 10 inches. Mr. Blitz felt the cones should be priced at 23¢ in styrene, 28¢ in acetate, and 40¢ in butyrate. For quantities above 5,000, he felt a two-cavity mold should be employed. This would give less shots per hour, but the higher production rate would bring the unit price for a styrene cone down to 19¢.

Vacuum forming offers many advantages, according to Daniel Lewis, Durable Formed Products, Inc., depending on the number and the required delivery date. Tooling would cost only $85, and 100 cones would cost around $200-225. Cost per unit for a 5,000 run was estimated at $1.95. Longer runs are not feasible, since delivery date would be about six months to a year, and the higher mold costs of the other molding methods would be amortized by that time. For the box, Mr. Lewis would use a high-impact copolymer sheeting. He felt that square corners should not be expected if good impact strength and finish are desired. Tooling would run about $125, and the price per box, formed from ¼-inch sheet, would be $14.95; $13.00, for a 5,000 run.

J. D. Bassin, Borden Co., presented the case for reinforced plastics. He felt that the cone, being an expendable, does not actually require the strength properties of reinforced plastics; however, their use would be quite feasible. For 100 cones, he would recommend matched plastic molds and room temperature cure. For 100,000 units, matched aluminum molds were suggested; chrome-plated steel molds numbers in excess of 50,000. Plastic molds were not recommended for heat cure, since the expansion factor for plastic is about 50×10^6 (as opposed to 10×10^6 for steel). Estimates for 100 cones would run about $2.75. Matched aluminum molds would cost about $150, but the unit price would drop to $1.00. Boxes would be produced in the same type molds; plastic molds costing $250, and aluminum molds running about $1,000. The costs per box would be $9.25 and $3.75, respectively.

Vinyl Molding Discussed

"Injection Molding of Rigid and Non-Rigid Vinyls" was the subject of the February 8 regular dinner meeting of the SPE Newark Section, held at the Military Park Hotel with 110 members and guests in attendance. The subject was covered by two speakers: J. H. Malone, B. F. Goodrich Chemical Co., who spoke on rigid vinyls, and J. H. Wilkinson, Bakelite Co., who discussed the non-rigid vinyls.

Mr. Malone began his talk by describing the two types of unplasticized PVC: Type I is of normal impact strength (0.8 Izod), while Type II is modified to give a high impact strength (15 Izod). Type I has higher tensile strength and better chemical resistance than Type II. For both transfer and injection molding, a stock temperature of 350-365° F. is recommended. In transfer molding, the pigs are preheated to the temperature and molded under pressures of 20,000-30,000 psi. In injection molding, the use of pre-plasticizing units and specially designed heating cylinders is recommended.

In discussing mold design, Mr. Malone recommended the use of large gates, large sprues, and chrome-plated molds. Mold temperature should be 130-140° F., or the mold can be cycled. Control of core temperature is important where a core is used.

Mr. Wilkinson devoted his talk to the importance of restricted gating in the injection molding of plasticized vinyls. Restricted gating has helped overcome the original deficiencies in molded gloss of elastomeric vinyls, and permits the lowering of cylinder temperatures. For this purpose, restricted gates are defined as being less than 0.025-inch in diameter. In describing Bakelite studies on various gating methods, the speaker noted that poorest results were obtained with a large ¼-inch diameter gate; better results were obtained with several restricted gating systems; and best results were given by a 0.020-inch diameter, 1/16-inch long gate having a well between the restriction and the actual entrance into the cavity.

The meeting closed with a drawing for door prizes contributed by Parkway Plastics Co.; Wheelco Instrument Div. of Barber-Coleman.; and F. W. Egan & Co.

Advance Program for SPI Pacific Coast Conference

The advance program for its thirteenth annual conference has been announced by SPI's Pacific Coast Section. Registration will take place on March 26, at the St. Francis Hotel, San Francisco, Calif., where technical sessions will be held on March 27 and the morning of March 28. That afternoon the members embark for Hawaii aboard the S. S. Lurline.

The conference opens with the annual business meeting, followed by a presentation on "The House of Tomorrow" by Marvin Goody, Associate Professor of Architecture, M.I.T., and Ralph Hansen, Monsanto Chemical Co. The rest of the program is outlined below.

Tuesday Afternoon, March 27

Aircraft and Missiles session, moderated by Carl Lemons, Douglas Aircraft Corp.:

"Applications of Honeycomb Structures in Aircraft and Missiles," Andrew C. Marshall, Hexcel Products, Inc.

"Quality Control in Reinforced Plastic Structures, Experimental to Production," Haig Haydostion, Hughes Aircraft Co.

"Reinforced Plastic in Aircraft Armament," Orson Mitchell, U. S. Naval Ordnance.

"Reinforced Plastic in Missiles," Max Nadler, North American Aviation.

"Reinforced Plastic Parts in Large Rocket Missiles," Charles Knight, Firestone Missile Division.

Thermplastics session, moderated by Ralph Hickox, Goodyear Chemical Division:

"Vinyls," Walter D. Lahey, B. F. Goodrich Co.

"Polyethylene," H. F. Robertson, Bakelite Co.

"Thermoplastic Structures," Ray Seymour, Loven Chemical Co. of Calif.

"Injection Molding Progress," Earl Kropscott, Dow Chemical Co.

"Molding Equipment," Thomas Bishop, Hydraulic Press Mfg. Co.

Wednesday Morning, March 28

Thermosetting session, moderated by Jack Williamson, Thalco Co.

"Reinforcing Fibers," Jess Plummer, Libby-Owens-Ford Glass Fibers, Inc.

"Advanced Molding Techniques," Edward F. Borro, Durez Plastics Division.

"High Strength Filament-Wound Tubular Structures," Carl de Ganahl, Spiral Glass Co.

"New Materials," R. W. Stephenson, Dronite Chemical Co.

"Polyurethane—A Material of the Future," R. B. Greene, Barrett Division, Allied Chemical & Dye Corp.

Plastic Container Panel

A panel discussion on plastic containers highlighted the February 16 joint dinner meeting of the SPE Eastern New England Section and the local chapter of SPI. Some 130 members and guests of the two groups attended the meeting which was held in the Hotel Beaconsfield, Brookline, Mass.

The meeting began with short talks by the panel members. Jack Kavanaugh, Standard Tool Co., described molds for making thin-walled (0.014-inch) containers. Michael Merrill, Dow Chemical Co., spoke on soft-flow materials which can be used for high-speed molding in conventional presses of thin-walled containers. George Whitehead, Improved Machinery Co., discussed the faster-operating molding machines and emphasized the importance of speed in mold closing and injecting the material. The final talk, giving the viewpoint of the plastics molder, was presented by John Adamitis, Beacon Plastics Co.

In the panel discussion which followed the talks, many subjects were raised by the audience. On the subject of temperature control in the gate area, it was noted that the area should be centered and cooled; a beryllium copper inset for good heat transfer is used for the mold portion adjacent to the container bottom; and a water jacket around the nozzle bushing should be used to control temperature in this area. In discussing mold design for thin-walled containers, it was noted that mold cost may be 50% higher than for conventional molds for heavy-walled sections, and the mold construction must be rugged to overcome the problem of core shifting.

Speaking of the number of mold cavities for thin-walled containers, it was pointed out that this number depends on both wall thickness and area of the moldings: the thinner the wall, the less the number of cavities; the larger the area, the less the cavities in number. Other subjects discussed by the panel brought out that injection rate and mold temperature control orientation and strains in the molded part; and that a two-cavity mold appears best at present for molding 16-ounce containers.

Discuss Polymer Radiation

"Application of Radiation to the High Polymer Field" was the topic discussed by David S. Ballantine at the January 24 joint meeting of the Philadelphia Sections of SPE and SPI, held at the Franklin Institute. Dr. Ballantine has been associated with various phases of the Oak Ridge atomic energy program, Kellex Corp., and the Brookhaven National Laboratory.

Experimental work was reviewed, pointing out applications where the physical properties of plastics had been altered by radiation. A case in point is the conversion of polyethylene to a high-melting material through exposure to gamma and X-rays, electrons emanating from radioactive beta decay, or machine accelerators. Neutron irradiation has not been used commercially, since it renders the plastic radioactive.

Molecular changes take place when a plastic is irradiated, and Dr. Ballantine pointed out how these changes could lead to gas formation, branching, cross-linking, or degradation, depending on the material and environment. He felt that irradiation-induced cross-linkage and degradation would have less commercial application than the use of this method to graft copolymers. In this way, the basic solid-properties of one plastic can be combined with the different surface properties of another. Permeable plastics have been treated at Brookhaven to make them resist penetration, as well as to bring about gross changes in their coefficients of friction.

New Officers for Kentuckiana

A talk on "Epon Resins and Their Applications in Plastic Tooling," by W. A. Hubbard, Shell Chemical Co., featured the dinner meeting on January 25 of the SPE Kentuckiana Section. Approximately 30 members and guests attended the meeting, held at Bauer's Restaurant, Louisville, Ky.

New officers of the Section were announced, as follows: president, K. A. Erwin, General Electric Co.; vice president, C. J. Young, Crescent Plastics; secretary, W. H. Bailey, Hoosier-Cardinal Co.; and treasurer, W. B. Watkins, Premier Thermoplastics. The board of directors consists of Messrs. Erwin, Bailey, and Watkins; J. R. Davidson, Hoosier-Cardinal; R. E. Eschenaur, U. S. Plywood Corp.; R. R. Millar, Plax Corp.; P. H. Rhodes, Kent Plastics; and E. H. Roberts and A. M. Varner, both of G-E. Mr. Varner, the outgoing president, thanked his retiring officers and committee chairmen for their work during the past year and announced that the Section membership has grown to 46 in less than a year.

Committee chairmen for 1956 were announced by Mr. Erwin, as follows: membership, A. J. Roche, Monsanto Chemical Co.; and publicity, R. O. Carhart, G-E.

ACS Medal Awarded to Marvel

Carl Shipp Marvel, research professor at the University of Illinois' Noyes Chemical Laboratory, has won the American Chemical Society's Priestly Medal for 1956, according to an announcement by John C. Warner, ACS president. The gold medal, highest honor in American chemistry, will be presented to Dr. Marvel for "distinguished services to chemistry" at the 129th national meeting of the Society, which will be held in April at Dallas, Tex.

Dr. Marvel was president of the Society in 1945, at which time he directed an important part of the World War II research program on synthetic rubber. He also served as chairman of the National Research Council's Panel on the Synthesis of Antimalarial Drugs. He is widely known for his contributions in the field of vinyl polymers, particularly with respect to transparent parts for aircraft, and thickeners and blending agents in the chemical manufacturing industry.

NEWS of the INDUSTRY

Anhydride Output to Rise

A 60% increase in phthalic anhydride production by expanding facilities at its Everett, Mass., plant is planned by Monsanto Chemical Co., St. Louis, Mo. Construction of the new facilities was expected to begin this month, and to be on stream early next year. Part of the expanded output is expected to go into the plant's phthalate ester production, which rose 50% over 1955 levels as the result of a recently-completed expansion.

According to Charles H. Sommer, Monsanto vice president and general manager of the firm's organic chemicals division, this scheduled expansion at Everett is based on anticipated growth in demand. Substantial increases took place last year in the production and consumption of both alkyd resins and phthalate esters, the two largest uses for phthalic anhydride.

New Plastics Company Formed

Interplastics Corp. New York, N. Y., has been formed by Gerald F. Bamberger, who resigned as executive vice president and general manager of A. Bamberger Corp. and American Molding Powder & Chemical Corp. He will be president of the new company, which will supply a complete line of thermoplastic molding powders, resins, and raw materials for both the domestic and foreign markets. The firm also will act as distributors and export agents for American manufacturers of plastics raw materials, and will import special types of plastics materials from abroad.

Henry F. Meckauer, formerly export manager of American Molding Powder & Chemical Corp., will be vice president of Interplastics. The new company has offices at 654 Madison Ave.

Role of Plastics Research

Research can be credited with building a broad product base on which the plastics industry grew 30% in 1955, according to Harold W. Mohrman, research director for the plastics division of Monsanto Chemical Co., Springfield, Mass. Speaking before a group of business leaders participating in a reseach tour sponsored by the New England Council, Dr. Mohrman stated that only a few fundamentally new plastics have been developed in recent years, but there has been a continual flow of new formulations from the industry's research laboratories. It has been chiefly these formulations and combinations of known plastics with other materials which have enabled the plastics industry to broaden its product base and win important new markets.

Monsanto's plastics research laboratories demonstrated more than 70 new formulations last year, and these have been turned over to other departments for field tests and evaluation, Dr. Mohrman stated. Many of these items are already being manufactured and sold commercially. "All-purpose plastics simply do not exist," he pointed out. "It is necessary to research constantly for end-use markets, and to work closely with our customers' development and research groups in specific application problems requiring new compositions."

To Make Polyolefin Plastics

Pullman, Inc., Chicago, Ill., has signed a license agreement with Phillips Petroleum Co., Bartlesville, Okla., to produce new types of polyolefin plastics. Ascording to Champ Carry, Pullman president, the new facilities required for production will require at least 18-24 months to erect. Mr. Carry stated that this move, which continues Pullman's general policy of diversification, broadens the present base in the plastics field of the company's subsidiary, The M. W. Kellogg Co., Jersey City, N. J.

The Phillips Polyolefin Process differs from those used commercially for the production of hydrocarbon resins in that it employs a new type of catalyst. This catalyst not only produces a unique type of polyethylene, but also is active in the copolymerization of mixtures of olefins. As such, the Process is said to be the first developed for converting ethylene mixed with other olefins into resin materials.

New U.S.I. Pilot Plant

A new half-million-dollar pilot plant building has been completed for U. S. Industrial Chemical Co., Division of National Distillers Products Corp., New York, N. Y. Located on the site of the firm's present research facilities in Cincinnati, O., the new building provides space and facilities for the final testing of processes and products developed by the research laboratories.

The new pilot plant building consists of a two-story general section of 2,800 square feet; a three-story special section of 4,300 square feet; four floors of air-conditioned offices and laboratories totaling 3,600

U. S. I. Pilot Plant Building in Cincinnati, O.

square feet; and a 4,000-square foot basement containing the machine shop, boiler, and air-conditioning plant. A split level arrangement between the general and special sections permits versatility for pilot installations. Basic research is done in the main laboratory building next to the new plant.

The first product to be piloted in the new building will be U.S.I. isosebacic acid, which will be produced in pilot quantities for evaluation. Other new sodium-consuming processes are under development in the research laboratory, and will soon reach pilot plant stage.

Offers Winding Service

Complete installation service in connection with the winding of webs or sheets of all types, including extruded plastics, is now available from Hobbs Mfg. Co., Worcester, Mass. Termed "engineered winding," the service offers the company's long experience in the design of slitting and winding equipment. Heretofore, plants that do winding have had to purchase various winder elements from different sources, or to build certain elements themselves.

After introducing its Hobbs-Alquist Winder a few years ago, Hobbs soon learned that each application is different from others, and that proper winding stands were essential to provide full scope for the machine. Hobbs has greatly augmented its engineering staff and is now able to analyze a customer's winding requirements in detail, as well as design and manufacture winders and stands to solve any winding problem. An "engineered installation" is shipped complete, ready for operation when installed. The company's engineers also assist in setting up installations and in getting them into satisfactory operation.

New Company to Make Records

American Sound Corp., a new company, has been formed jointly by Allied Record Mfg. Co., Hollywood, Calif., and Bart Mfg. Corp., Belleville, N. J. Operating through its Allied Record Division and utilizing the engineering facilites of Bart, the new company's currently building a large-capacity factory in Belleville, N. J. This new plant, scheduled to begin operations on March 1, will provide high-speed facil-

for the volume production of custom-
le records, matrices, tape duplications,
milling of all types of record biscuits
materials.

he parent companies will continue their
vidual activities and operations, inde-
lent of each other. Allied Record Mfg.
until mid-1954, a major custom man-
turer of records and transcriptions in
New York area. Bart Mfg. was former-
leading manufacturer of custom ma-
s for record plants. The new firm will
headed by the following officers: chair-
of the board, D. K. Broadhead, also
ident of Allied Record Mfg.; president,
G. Bart, also president of Bart Mfg.;
vice presidents, N. M. Messing and
G. Olson.

Build PVC Resin Plant

contract for the construction of a poly-
l chloride resin plant near Pensacola,
has been awarded by Escambia Bay
mical Co., Cambridge, Mass., to the
w-Knox Co. The new multi-million
r facility will have an annual produc-
capacity of 30,000,000 pounds, and will
k Escambia's entry into the resin field.
new plant is scheduled for completion
this year.

he plant will provide a complete line of
pension-type, easy-processing PVC resins
electrical, sheeting, extrusion, and film
lications. Production of the resins will
under the supervision of Joseph Gaf-
, formerly with B. F. Goodrich Chem-
Co., while W. W. Peacock, Jr., previ-
y with Naugatuck Chemical Div.,
ited States Rubber Co., will be sales
nager for Escambia's plastics.

Build New Cycolac Plant

A major expansion in the plastics manu-
turing field has been undertaken by
g-Warner Corp., Chicago, Ill., by ap-
priating $10-million for the erection
a new chemical plant on a recently-
chased 322-acre site in Washington,
Va. Construction of the new plant was
ssitated by the increasing demand for
olac thermoplastic resin, which was
eloped and is being produced by the
pany's Marbon Chemical Division in
plants at Gary, Ind.

he new plant will consist of a series
individual buildings covering nearly
-half acre, with a substantial section
he plant to be devoted to facilities for
cessing Cycolac into a variety of colors.
high-impact, acrylonitrile-butadiene-
ene resin, Cycolac has found many
dreds of uses in general industry. It is
to have the toughness of rubber, and to
roach the surface hardness of most non-
ous metals.

St. Regis Paper Buys Chester

St. Regis Paper Co., New York, N. Y., is acquiring all of the capital stock of Chester Packaging Products Corp., Yonkers, N. Y., by the exchange of its common stock for Chester stock. Chester produces unsupported polyethylene film used in the packaging industry; laminates and coats polyethylene to cellophane, foil, and kraft paper; and manufactures extruded polyethylene pipe. After the stock transaction, Chester will operate as a subsidiary of St. Regis, with no change in its present organization or management. The acquisition of Chester rounds out the areas in which the Panelyte Division of St. Regis is working with polyethylene.

As a further step in its expansion in the thermoplastics field, Panelyte is opening a new thermoplastics laboratory at Richmond, Ind., where it has plants for injection molding and vacuum forming. The new laboratory will be concerned with the development of new processes and applications for thermoplastics, and the study of materials and equipment for use in manufacture. The new facility will be headed by P. E. Schmidt, Panelyte's chief thermoplastics engineer.

Pipe Approval Seal Program

An identification program for plastic pipe has been jointly announced by the Society of the Plastics Industry, Inc., New York, N. Y., and the National Sanitation Foundation, Ann Arbor, Mich. Effective February 1, the program is designed to assure the public of safe, uniform quality in plastic pipe indentified by the Foundation as being suitable for use in transporting potable water, on the basis of requirements established as a result of the Foundation's recently-completed plastic pipe investigation study. This study tested 22 samples of plastic pipe to determine their suitability for underground use in conducting cold drinking water.

Companies participating in the program will identify their pipe and fittings with the NSF seal of approval. The companies will have their plants inspected regularly by Foundation officials, and must meet minimum established standards. In addition, their pipe will be tested regularly for possible effects on the appearance, taste, and odor of water. Manufacturers of raw materials used in plastic pipe must obtain NSF approval of their materials and, in turn, notify their customers of such approval.

New Du Pont Isocyanates Plant in Production

The new Hylene isocyanates plant of E. I. du Pont de Nemours & Co., Wilmington, Del., is now in production. Geared to make 25-million pounds of these versatile chemicals per year, the plant is located at the company's Chambers Works in Deepwater Point, N. J., and currently employs more than 100 people.

Organic isocyanates, of the types being made at the new plant, can be combined with other compounds to form plastic-like and rubber-like materials having wide use potentials in the building, transportation, upholstery, and insulation fields. Many new materials, ranging from rigid and flexible foams to a new experimental synthetic rubber for auto tires, can be made by reacting polyisocyanates with alkyd resins, alcohol, amines, or water. Du Pont does not make any end-products of this type, but supplies only the basic isocyanates.

The isocyanate foams combine unusually high strength, toughness, and resistance to shock and vibration with light weight, resilience equivalent to foam rubber, high sound absorption qualites, low thermal conductivity, and ability to be foamed in place rapidly (less than 15 minutes) at room temperature. When foamed in place, the material bonds firmly to adjacent surfaces, whether metal, wood, masonry, glass, or fabric.

New Du Pont isocyanates plant in Deepwater Point, N. J.

Architect's drawing of new Resistoflex plant in Roseland, N. J.

New Plant for Resistoflex

The occupancy of a new plant and research facility at Roseland, N. J., that doubles its former capacity, has been announced by Resistoflex Corp., makers of special hoses and hose assemblies and fabricator of plastics for critical aircraft and industrial applications. The modern, 55,000-square foot plant was designed to house the company's operations in research, development, and production of moldings and extrusions from special synthetic materials. These products are made to precision standards.

A substantial addition to the new plant is already under construction, to meet the demand for Fluroflex-T R500 hose used for high temperature applications in the aircraft field.

Plastics Overseas Exhibit

"Plastics in America" is the title of the first complete exhibition built almost entirely of plastic for use by the overseas exhibition program of the U. S. Information Agency. Organized by the Smithsonian Institution in cooperation with the Society of the Plastics Industry, Inc., the exhibit was designed by Will Burtin and constructed by The Displayers, Inc.

Before being shipped abroad, the exhibit was previewed at the Carnegie Endowment International Center in the United Nations Plaza, New York City. Over 400 plastic objects are used in the display, showing the employment of plastics in the United States for home, business, and industrial life.

Except for steel frames, the exhibit is constructed entirely of plastic, demonstrating the versatility and practicality of the material. Light, space, and transparent plastic panels are used to create an effect of openness and freedom in the display.

"Plastics in America" exhibit is of all-plastic construction, except for steel frames.

In Brief . . .

Snyder Chemical Corp., Bethel, Conn., has adopted a new corporate name, Synco Resins, Inc., effective the first of the year. The new name, based on the trademark for the company's products, expresses more clearly the corporate business which will continue to be based on the synthesis of resins, particularly phenolics, to specific requirements of users.

Union Carbide & Carbon Corp., New York, N. Y., has formed a new silicones division to take over responsibility for development, manufacture, and sale of silicone products, previously handled by Linde Air Products Co. Officers of the new division include W. B. Humes, president, and T. J. Coleman, general manager.

Dow Chemical Co., Midland, Mich., has reduced tank car prices for styrene RG and vinyl toluene to 16.5¢ per pound f.o.b. buyer's destination, freight prepaid. The reduction amounts to ½¢ per pound on the two monomers.

Clopay Corp., Cincinnati, O., has licensed Canadian General-Tower, Ltd., Galt, Ont., as the sole manufacturer and exclusive seller of the Clopay Accordion Door in Canada. Canadian General will manufacture the door at the Galt plant, and will embark on an extensive sales promotion plan for the doors in the Canadian market.

Acheson Dispersed Pigments Co., Philadelphia, Pa., has announced drastic price reductions in processing charges for dispersing carbon black and pigments in polyethylene. These reductions are said to result from increased productive volume of dispersions in polyethylenue, and Acheson's installation of new equipment and more efficient methods of dispersing pigments.

Carbide & Carbon Chemicals Co., New York, N. Y., has opened a new warehouse in Birmingham, Ala. At present, almost 24 of the company's chemical products are stocked at the new warehouse.

Cadillac Plastic & Chemical Co., Det Mich., is manufacturing cast acrylic sh in thicknesses from 5-10 inches. Mad 24-inch square sizes, the sheets are g to be perfectly clear, without flaw bubbles, and eliminate the need for la nating to obtain the desired thickness many applications. The sheets are avail from the company's warehouses in Det Chicago, St. Louis, Los Angeles, and Francisco.

Bakelite Co., New York, N. Y., nounced a substantial reduction in vi resin prices, effective January 9. The duction ranges from 8½-13%, depend on type of resin. Polyvinyl chloride re resins, such as the company's VYN were reduced from 31¢ to 27¢ per pou and vinyl chloride-acetate copolymer re such as VYHH, were lowered from to 32¢ per pound. Other Bakelite vi resins were reduced comparably in pr

E. I. du Pont de Nemours & C Wilmington, Del., reduced the price Mylar polyester film by 25¢ per pou Effective January 17, the reduction appl to all types and gages of film, except 25- and 35-gage film. This reduction is third since the start of commercial op ations at the company's Circleville, plant in the fall of 1954. Mylar pri now range from $2.25 per pound for most heavy gages to $4 per pound for 25-gage film.

Commonwealth Pipe & Tubing, In Philadelphia, Pa., is a new entry into plastics extrusion field. The new firm w specialize in sales of wood and metal m coated with various plastics, and the pr duction of tubing in different sizes fr vinyl and polyethylene. S. B. Gross is v president of the new company.

Automatic Molding Machine Co., Angeles, Calif., have appointed West Co Plastics Distributors, Inc., Culver C Calif., as distributors for its line of Au mold high-speed automatic compressi molding machines in the Southern C fornia area.

E. I. du Pont de Nemours & Co., W mington, Del., has announced a price duction for Zytel nylon, effective Febru 15. The prices of most compositions natural color will be cut 10¢ per pou while prices of colored resins will be duced 5¢ per pound. Zytel 101, used general purpose molding, will be priced $1.35 on orders ranging from 2,000-20,0 pounds, while carload shipments will priced at $1.33 per pound. Zytel 61, soluble resin for films, coatings, and ishes, and Zytel 63, a special composi for extrusion, will be priced at $1.83 pound in carload shipments.

News from Abroad

an Brazil Polyethylene Plant

Plans for the construction of a polyylene plant in Brazil have been anounced by Union Carbide & Carbon rp., New York, N. Y. This latest addiin to the firm's growing group of overas polyethylene plants will be erected and erated by a wholly-owned subsidiary, nion Carbide do Brasil, S.A.

To be located at Cubatao, near Santos, e plant will be adjacent to the refinery d ethylene plant of Petrobras, the Brazian government agency that controls e major refining operations in that untry. A contract between this agency d the new Carbide subsidiary, signed ugust 4, assures the new plant of adeate supplies of ethylene on a long-term sis. Land for the plant has been purased, and engineering and equipment rocurement is under way.

The new plant will have sufficient capacy to satisfy completely the most optimistic timates of Brazil's polyethylene requirents over the next 5-10 years. It will be so nstructed that its productive capacity can increased at any time by making relaely simple additions and minor alterans.

rganizes Indian Firm

Dow Chemical Co., Midland, Mich., d Kilachand, Devchand & Co., Ltd., of dia, have formed a company to manucture Styron, Dow's polystyrene. The w firm will erect a plant near Bombay, hich will have a yearly capacity of 700 metric tons.

The two parent organizations will each old 25% of the capital stock; the remaing 50% to be offered for sale to the dian public. Dow will supply technical sistance and provide training for key rsonnel. The Indian firm is a well-known anufacturer of textiles, heavy machinery, d chemicals.

olyamide-Coated Wire Cables

The only factory outside of the United tates to produce polyamide-coated steel ire cable, is the N.V. Staaldraadkabel-en erculestouwfabriek v/h J. C. den Haan, Gornichem, Netherlands. This firm uses kulon, the Dutch nylon-type plastic. The kulon is extruded onto steel wire rope if e diameter is up to 0.63 inch, forming a osely fitting, smooth coat. For cables of rger diameter, the individual strands first are coated with the plastic, then twisted to form the cable. The coating is said to give wire ropes and cables greater resistance to fatigue, corrosion, dilute acids and alkalies, wear, and damage.

Flame-Resistant Polymers

More than 300 persons attended the Symposium on Flame-Resistant Polymers held in London, England, on November 23 and 24, 1955, and the lively discussions following each of the lectures testified to the keen interest in the problems treated.

Highlights from these papers follow:

"P.V.C. and Related Polymers," S. J. Skinner, British Geon, Ltd. In connection with conveyor belt fires, it was brought out that though the coefficient of friction for PVC is lower than for rubber, provision of satisfactory installations is an engineering rather than a compounding problem. From the audience came the remark that in the wet state the coefficients of friction of PVC and rubber are reversed and that much coal is wet when transported.

"Chlorinated Rubber and Chlorinated Paraffin Wax," H. E. Parker, Imperial Chemical Industries. With about 42% chlorine content, chlorinated paraffin wax is a viscous liquid; with 70% chlorine, a resinous solid. It is used in combination with chlorinated rubber in flame-retarding paints and in textile proofing, and can be used to impart flame resistance to polyester resins, among others.

"Prospects for the Application of Organic Fluorine Compounds," M. Stacey, University of Birmingham. At present, development work on organic fluorine compounds is being left mainly to the Americans. The speaker called urgently on the British industry to do more in this direction. British industry appears interested only in large-scale production, but what is really needed is the production and evaluation of a large number of small quantities of the new polymers. His own unit, Prof. Stacey added, is attempting to provide quantities of 200-300 cc. for test purposes.

"Organic Phosphorous Compounds for Textiles," F. Tattersall, Proban, Ltd. A new means of flame-proofing fabrics has been developed by Proban. This is THPC, based on tetrakis (hydroxy methyl) phosphonium chloride, and is believed to be the most satisfying material yet devised for safe and effective treatment of cellulosic fibers.

"Fire Hazards in Clothing," Vera Colebrook, Lecturer. This was a plea for greater knowledge of the fire hazards from fabric to prevent burns, especially among children, from unsafe clothing.

"Flame-Resistant Rubber," J. R. Phillips, Dunlop Rubber Co., and J. R. Scott, Research Association of British Rubber Manufacturers. The silicone rubbers open up new possibilities closed to other synthetic and natural rubbers. Though not completely flame-resistant, silicone rubbers will withstand temperatures which will destroy rubber articles, whether treated with fire-proofing agents or not.

"Flame Resistance of Neoprene and Hypalon," H. J. Lanning, Durham Raw Materials, Ltd. While flame-resistant PVC belts apparently are preferred in Britain, there is a trend toward neoprene belts in the United States and Germany. Hypalon is flame-resistant, has better heat resistance than neoprene and is completely ozone resistant.

"Thermosetting Resins," C. P. Vale, B.I.P. Chemicals, Ltd. The danger of stiffening nylon net with melamine resins arises from the tendency of the resin to prevent the normal habit of nylon (to melt and flee from flame), thus causing the fabric to ignite. To prevent this, thiourea-modified urea-formaldehyde resins are recommended.

"P.T.F.E. and P.T.F.C.E.," Gadsby, I.C.I. plastics division. Entirely new plastic processing techniques, comparable to powder metallurgy, have been devised for these high polymers. The speaker described uses of the new products for carrying fuel in aircraft; in unlubricated bearings of "metal sponge" impregnated with PTFE; in mines; and in accumulator brushes for high altitude flight (when a mixture of 20% PTFE with graphite gives reduced risk from sparking).

Although not dealing specifically with flame resistance, mention should be made of remarks at the Symposium dinner by B. S. Shenstone, of British European Airways, on the failings of rubber and plastics in aircraft applications. These failings are: (1) Plastic laminate table-tops in aircraft galleys tend to chip, dent, break, or wear away too quickly; (2) The very expensive synthetic rubber fuel tanks are attacked by ozone at operating altitudes up to 30,000 feet (when overhauled, they sometimes distort and fail to fit properly); (3) Plastic wine glasses, though unbreakable, scratch easily and cost more than ordinary glasses but last no longer; (4) Thermoplastic wash basins scratch easily and crack at the outlet, so that stainless steel basins are coming back in many cases; (5) Even when no freight is carried, rigid plastic linings of freight holds buckle and crack around the rivets; (6) Cabin linings of PVC-coated cloth fade; and (7) Cream-colored PVC netting used for baggage racks darkens with age.

NAMES in the NEWS

Fabian Bachrach

A. K. Doolittle

A. K. Doolittle has been named a senior scientist in the research department of Carbide & Carbon Chemicals Co., New York, N. Y., where he will direct a broad program of basic research in liquid-state physics. He joined the firm in 1932 as technical head of coatings research, and was appointed assistant director of research in 1944. The areas in which he has specialized include surface coatings, solvents, plasticizers, plastics applications, and the theories of liquids, solutions, and viscosity.

Appointments in the research department of Carbide & Carbon Chemicals Co., New York, N. Y., have been announced as follows:

W. N. Stoops, as associate director.

D. M. Young, as assistant to the research director.

H. C. Chitwood, B. J. Cottrell, Benjamin Phillips, G. M. Powell, and **A. T. Walter,** as assistant directors.

George E. Patterson has been named plant engineer for the North Tonawanda, N. Y., plant of Durez Plastics Division, Hooker Electrochemical Co., Niagara Falls, N. Y. He will be in charge of all maintenance and basic service facilities, as well as minor project work at the plant. A mechanical engineering graduate from Cornell University, **Mr. Patterson** was with Semet-Solvay Div., Allied Chemical & Dye Corp., and Sharples Chemicals, Inc., prior to joining Durez in 1946 as a project engineer.

J. L. Mattson has been named district manager of the San Francisco office for Witco Chemical Co., New York, N. Y. His former position in the company's Los Angeles office has been assumed by **Harold L. McKinsey. Mr. Mattson** joined the Witco sales staff in 1955, after having been associated with Borden Co., National Lead Co., International Shoe Co., and Andrew Brown Co.

Robert G. Wiese has been appointed to the technical sales department of Glyco Products Co., Inc., New York, N. Y. Formerly with Owersey Corp., he has been assigned to Glyco's Chicago district office and will assist in covering Northern Illinois, Wisconsin, and Minnesota.

Hall Rainwater Wells has been named sales representative for the northern California area by Tee-Pak, Inc., Chicago, Ill., makers of cellulose casings and plastic packages for food products. Formerly with San Francisco Casing Co., Leo J. Meyberg Co., and United Airlines, **Mr. Wells** has been assigned to Tee-Pak's West Coast branch plant at San Francisco, Calif.

Warren W. Joll

Robert F. Gager

Robert F. Gager has been elected vice president—research for Synco Resins, Inc., Bethel, Conn. He formerly was the company's director of research. Before coming to Synco, Mr. Gager was chief chemist for Varcum Chemical Corp., and senior chemist in Du Pont's electrochemical department.

Salvatore P. Lio has been named assistant sales manager for styrene molding materials for the plastics division, Monsanto Chemical Co., Springfield, Mass. A chemical engineering graduate from Pennsylvania State University, **Mr. Lio** joined Monsanto in 1942 as a research chemist; held various supervisory positions in the production department at Springfield; and since 1950 has been manager of the Mexico City plant of Monsanto Mexicana, a subsidiary company which makes plastics and chemicals.

Harold W. Hoots has been appointed midwest sales representative for Premium Plastics, Inc., Chicago, Ill. He was formerly the western branch manager for Rite-Way Dairy Div., Package Machinery Co.

S. M. Wood

Stewart M. Wood has been appointed sales manager for Ball & Jewell, Brooklyn, N. Y., manufacturers of plastics grinding machinery.

Martin J. Tierney has been appointed commercial development manager for Naugatuck Chemical Div., United States Rubber Co., New York, N. Y. Formerly assistant commercial development manager, he replaces Clayton Ruebensaal who is now director of commercial planning for Texas-U.S. Chemical Co.

Several changes in the industrial chemical sales organization of **Carbide & Carbon Chemicals Co.,** New York, N. Y., have been announced, as follows:

M. W. Duncan, appointed Kansas City district manager.

T. F. Gray, transferred to the Denver sales office as technical representative.

R. E. Gustafson, appointed technical representative in the Chicago district.

M. H. MacKay, transferred to the Chicago district office as an inside salesman.

W. R. Ayers has been appointed assistant director of engineering for the plastics division of Monsanto Chemical Co., Springfield, Mass. Recently on special project assignments, he joined Monsanto's John F. Queeny plant in St. Louis, Mo., as an analytical chemist in 1937. He was transferred to the plastics division in 1946 serving successively as a research group leader, operating superintendent, and general manufacturing superintendent.

C. V. Nicholson

Charles V. Nicholson, formerly manager of the company's international division, has been named general manager of product sales for F. J. Stokes Machine Co., Philadelphia, Pa. In his new position, he will direct all headquarters sales and marketing activities, both domestic and overseas, for all of the Stokes product lines. Mr. Nicholson graduated from Wharton School of Finance and Commerce, University of Pennsylvania in 1933, was associated with Henry Disston & Sons, Inc., served with the Air Force during World War II, and joined Stokes in 1954.

Harris S. Woodman, former president of Interchemical Corp.'s Wadsworth & Woodman Division, Winthrop, Me., has been named Division chairman. **Floyd Anderson,** formerly general manager and controller of the Division, has been appointed general manager with the active management responsibility. The Division produces imitation leathers and other coated fabrics for use in shoes, rainwear, sanitary fabrics, and others. **Mr. Woodman** will continue as an active consultant for the Division, and assume a similar function for Interchemical's Cotan Division, Newark, N. J., also makers of coated fabrics.

Blackstone Studios

Gerard C. Heldrich, Sr.

Gerard C. Heldrich, Sr., has been appointed technical service director for Grace Chemical Research & Development Co., division of W. R. Grace & Co., New York, N. Y. He formerly served as plant manager for Mills Plastic division, Continental Can Co., divisional manager of Gering Products' Extruded Products division, and as chief chemist for Plax Corp.

Harry M. Walker has been promoted to manager of the research department at the Texas City, Tex., research laboratories of Monsanto Chemical Co.'s plastics division, Springfield, Mass. **Dr. Walker** joined Monsanto in 1949 as a research chemist, being promoted to assistant group leader in 1952, and group leader in 1953. In his new position, he will be responsible for guiding the long-range development program in Texas City toward the most effective utilization of raw materials and technology.

Claude L. Boring

Claude L. Boring has been named general manager of Erie Foundry Co., Erie, Pa., manufacturer of forging hammers, trimming presses, and hydraulic presses. He has been serving as assistant to the president for the past year, and prior to that was divisional vice president of Plumb Tool Co.

OBITUARY

DeForest Lott

DeForest Lott, 57, chief development engineer of Textileather Division, General Tire & Rubber Co., Toledo, O., died at his home, February 11, following a heart attack. Mr. Lott began his career with the Textileather Co., coming to Toledo after the firm consolidated with Maumee Finishing Works. Before the 1954 merger with General Tire, he served as a vice president.

During his 33-year tenure with Textileather Co., Mr. Lott had been research manager, technical director, production assistant, and plant manager. His most recent duties included technical planning, counsel, and product development work.

Mr. Lott was a member of the Vinyl Fabrics Institute's technical committee, and was its former chairman. He was also a member of the industry advisory board of the U. S. Quartermaster Corps, Joint Chiefs of Staff, on coated fabrics and films.

Funeral services were held in Toledo on February 14. Mr. Lott is survived by his wife, Eleanore; and a son, Peter.

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New Materials

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Secondary Vinyl Plasticizer

A didecyl adipate plasticizer, said to impart low-temperature flexibility, low volatility, low specific gravity, and heat and light stability to vinyl resins and copolymers, has been made available in commercial quantities by Carbide & Carbon Chemicals Co. Designated Flexol 10-A, the material is recommended for use in combination with general-purpose plasticizers, since some "sweat-out" is observed when the material is used alone in high concentrations for calender films.

Low initial viscosity and superior viscosity stability are imparted to vinyl dispersions, an important feature in plastisol cloth coating and molding operations. Reduced volatility and improved resistance to water extraction also are cited as contributing factors to its selection.

Following are preformance data in vinyl compounds, based on 40 parts plasticizer to 100 parts Bakelite vinyl resin VYNW:

Hardness, Durometer A	88
Tensile strength, psi.	3,210
Ultimate elongation, %	270
Elongation at 1,000 psi., %	16
Stiffness at 23° C., psi.	8,100
Brittle point, °C.	—44
Four-mil film, after 24 hrs. @ 70° C.:	
SPI volatility, wt. loss, %	3.8
Water extraction, activated carbon, wt. loss, %	1
After 10 days @ 23° C., wt. loss, %	0.2
Oil extraction at 50° C., K value	5.1
Rub-off at 50° C., K value	4
Lacquer marring, 1 hr. @ 40° C., % softening	<10

Readers' Service Item M-1

Low-Viscosity Epoxy Resin

A 100%-reactive epoxy resin, said to be especially useful in the preparation of laminates by the vacuum bag and contact pressure methods, has been introduced by Shell Chemical Corp. Designated Epon 815, the resin has a viscosity of only 500-900 cps., which permits rapid penetration of the most closely-woven glass cloth. Since higher glass contents (60% by contact pressure method, 70% by vacuum bag) are possible, laminates of greater strength can be produced.

Casting materials based on Epon 815 can incorporate more filler, permitting better control of exothermic heat and shrinkage. This feature also makes it possible to formulate adhesives whose coefficients of expansion more closely match those of metal adherents. In preparing vertical laminates for tooling and patching applications, it is usually advantageous to add 2-4% of a suitable thixotropic agent to prevent excessive run-out, while still allowing sufficient wetting of the glass fibers and substrate.

Epon 815 can be cured with all curing agents used for Shell's Epons 828 and 834, and the same curing schedules are recommended. Laminates are usually tack-free in approximately four hours, and cure can be expedited by heating. Based on Shell schedules, laminates containing 39% resin show an ultimate flexural strength of 36,000 psi., and a flexural modulus of 2 x 10^6 psi. Another laminate produced by the vacuum bag method and containing 29% resin showed an ultimate flexural strength of 61,000 psi., and a flexural modulus of 3.4.

Readers' Service Item M-2

Epoxy Laminating Resin

A thermosetting, modified epoxy resin, said to feature excellent dimensional stability, has been placed on the market by Rezolin, Inc. Designated L-904, the material is white in color and demonstrates fine liquid-life properties. The formulation permits direct addition to the hardener, and mixing is accomplished by stirring at 100 rpm. for five minutes.

The finished laminate hardens at ambient room temperature, and ultimate psysical properties are attained in seven days. Resin properties are quoted as follows:

Gel time, min.	10-12
Applied gel time, hrs.	2.75-3.25
At 90° F.	0.75-1.25
Hardening time,	
60° F., hrs.	1.75-2.25
At 90° F.	0.75-1.25
Viscosity @ 73.4° F., cps.	1,000-5,000
On mixing	3,000-10,000
Shrinkage, inches/in.	0.0001-0.0005
Hardness of laminate,	
Shore D	86-88
Wetability	Excellent
Brushing	Excellent
Specific gravity	1.81-1.83
Density, lbs./cu.in.	0.049
Specific volume, cu. in./lb.	20.4
Inflammability of cured laminate	Self extinguishing
Effect of weak alkalis	None
Strong alkalis	Slight
Effect of weak acids	None
Strong acids	Attacked by some
Heat distortion temperature of laminate, °F.	400
Coefficient of linear thermal expansion	26 x 10^{-6}
Tensile strength, psi.	28,000-30,000
Compression strength, edgewise, psi	18,000-20,000
Flexural strength, psi	33,000-35,000
Machineability	Good

Readers' Service Item M-3

Polyethylene Molding Material

Catalin Corp. of America has announced the introduction of a polyethylene molding compound designated 15-5, the first in a series of polyethylene formulations. A general-purpose formulation, the material shows the following property values by ASTM test methods:

Specific gravity	0.916
Melt index, gms./10 min.	2-3.5
Softening point, °C.	105-110
Brittleness point, °C.	—75
Tensile strength, yield, psi.	1,150
Fail	1,800
Tensile elongation, yield, %	120
Fail	500
Tensile modulus, psi.	24,000
Hardness	C73
Dielectric constant	2.3
Dissipation factor	0.0005
Moisture absorption, %	0.01
Bulk density, lbs./ cu.ft.	30-33
Injection pressure, psi.	5,000-15,000
Cylinder temperature, °F.	275-650

Readers' Service Item M-4

Thixotropic Epoxy Resin

A non-flowing epoxy paste resin, said to offer complete penetration and bond in vertical laminates, has been introduced by Furane Plastics, Inc. Only a small amount of filler has been added, yet Epocast 2C is virtually drip-proof. Laminates reportedly possess all the strength, permanence, stability, and low shrinkage properties characteristic of epoxies.

In application, the use of 10% of Hardener 2C is recommended for the resin. The resin is brushed on the desired surface, and the glass cloth roughly pressed into place by hand. A squeegee or roller is then applied, causing the resin to penetrate the cloth. Pot life is estimated at 20-30 minutes, and full cure is obtained in 24 hours at 80° F.

Readers' Service Item M-5

dmium Stabilizer for Vinyl

dvastab C-77, a complex organic cad- n compound which does not contain fatty acids, is available from Advance ents & Chemical Corp. for use in the and light stabilization of vinyls. The rial is a clear, straw-colored liquid g a specific gravity of 1.057 and a ht of 8.82 pounds per gallon. The sta- er is soluble in the plasticizers and nts used in the vinyl industry.

he material was especially developed vercome the plating difficulties encoun- with barium-cadmium laurate type ilizers when they are used in high s. By keeping the Ba-Cd laurate ratio minimum (not higher than 1.25 parts 100 parts of PVC resin), enough lubri- n is provided and excellent stabiliza- obtained with the use of Advastab , and the plating is eliminated.

he new material is said to be superior arium-cadmium laurate type stabilizers, as the company's Advastab BC-12, in ilizing vinyl stocks that contain heat- itive organic pigments, especially the types. In stocks containing high per- ages of phosphate plasticizers, C-77 provide good stability without pro- nced color changes. With ester-type ticizers, the material provides excellent stability, exceeding 1,000 hours in the e-O-Meter, and has passed outside thering tests. The clarity of press- hed sheets stabilized with C-77 is re- ed to be outstanding.

Readers' Service Item M-6

icone Mold Release Agent

A pure-silicone mold release agent has n introduced on the market by Perc. E. ms Co. Called Slide, the product re- tedly contains 100% silicones with no litives. Packaged in a 20-ounce aerosol with either D-77 or all-metal vertical ves, the product is said to be particularly pted to both injection and compression ding of plastics. The large container is med to be roughly twice the size of peting mold release sprays, thereby ring a 40% cost savings to the molder.

Readers' Service Item M-7

o Vinyl Spray Plastisols

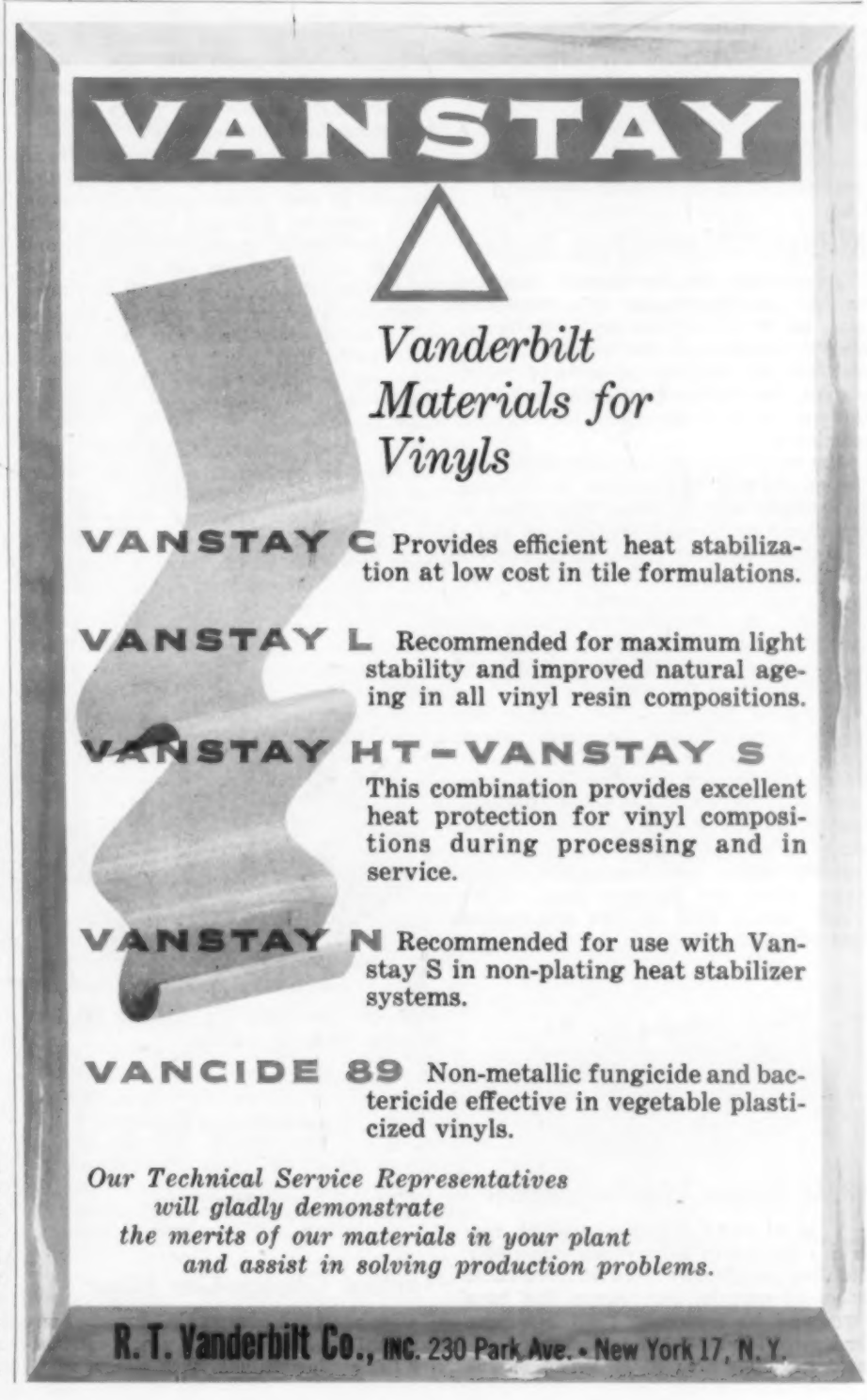
Two vinyl plastisols, both of which can sprayed at 100% solids, have been in- duced by Stanley Chemical Co. Desig- ed 77X-2143 and 77X-2176, the mate- ls contain no volatile ingredients and y be applied without the use of thinner diluent.

Formulation 77X-2143 is intended for plications where the required film thick- s does not exceed 20 mils, and is avail- able in a limited number of colors. Films 60-90 mils thick can be obtained with 77X2176, which is formulated in black only. The latter formulation is applied in multiple coats, but does not require heating between spray coats in 20-50 mil thicknesses.

The plastisols may be applied to properly primed, cold metal surfaces and, within certain limitations, will not sag or run on vertical surfaces. The object being coated should be cleaned by solvents, bonderizing, or any similar technique. For good adhesion, a diluted primer such as Stanley 40X-415 should be applied over the entire area. This coat should be either air-dried or baked for about 15 minutes. Over-baking will cause lack of adhesion to the subsequent plastisol coat.

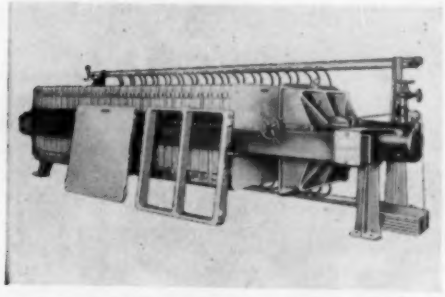
The plastisol is sprayed over the primed object, and baked at 375-400° F. for 10 minutes or longer, depending on the object's mass. For smoother surfaces, the formulation can be reduced, then air-dried for a minimum of 10 minutes before oven cure. If thinned, the plastisol should be air-dried between coats; however, this applies only to the coating of small panels.

Readers' Service Item M-8


VANSTAY
Vanderbilt
Materials for
Vinyls
VANSTAY C Provides efficient heat stabilization at low cost in tile formulations.
VANSTAY L Recommended for maximum light stability and improved natural ageing in all vinyl resin compositions.
VANSTAY HT–VANSTAY S
This combination provides excellent heat protection for vinyl compositions during processing and in service.
VANSTAY N Recommended for use with Vanstay S in non-plating heat stabilizer systems.
VANCIDE 89 Non-metallic fungicide and bactericide effective in vegetable plasticized vinyls.
Our Technical Service Representatives
will gladly demonstrate
the merits of our materials in your plant
and assist in solving production problems.
R. T. Vanderbilt Co., INC. 230 Park Ave. • New York 17, N. Y.

New Equipment

Write item numbers on Readers' Service card to obtain more information.



Shriver Reactor with 30 chambers, capable of producing 24 by 52 by 5-inch slabs.

Multiple Chamber-Type Reactor

A multiple chamber reactor, designed to effect polymerization at a controlled rate, has been designed by T. Shriver & Co., Inc. Consisting of a series of frames set between hollow, flat-surfaced metal platens, the reactor is said to produce a uniform product throughout an extended reaction period.

Hot water or steam is circulated through the platens until the reaction temperature is reached. At this point, cold water is substituted to control the rate of polymerization until the plastic reaches either the desired degree of viscosity or a completely solid state, as required.

Since each platen presents a large surface area, the plastic responds quickly to the heating or cooling medium, preventing rapid changes in the material.

Maximum heating surface within the platen is assured since the hollow spaces are cored, rather than cast in the form of tubing. Platens are available in any size from 12 to 56 inches, and frame thickness can be varied to produce slabs of 1-5 inches in thickness. Each platen has flexible hose connections to the heating and cooling water supply and discharge lines. A hydraulic ram is used to close and tighten both platens and frames.

Readers' Service Item E-1

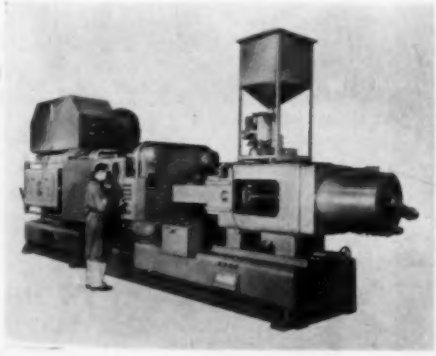
48/64-Ounce Injection Molder

A 48/64-ounce injection molding machine (capacity in polystyrene), reportedly featuring an injection speed of 2,410 cubic inches of material per minute, has been introduced by Hydraulic Press Mfg. Co. Designated Model 800-H-48, the unit has a mold mounting area of 36 by 54 inches, and a 35-inch mold clamp stroke.

The injection unit is actuated by a single hydraulic cylinder which loads, retracts, and effects a positive sprue break. A dual injection pump permits two-speed and dual-pressure injection which, in turn, allows the injection pressure to be reduced automatically after the mold cavities have been filled. A high-pressure axial piston pump develops maximum clamp pressure, and a high-capacity double-vane pump operates the clamp and injection rams.

A straight-line, fully-hydraulic mold clamp provides for fast opening and closing speeds, as well as automatic slow-downs. This particular feature is invaluable prior to mold contact, at mold breakaway, and during ejection of the molded part. The plasticizing chamber is equipped with three zones, each pyrometer controlled. Heating bands are mounted directly on the spreader, and the heating chamber is easily removable by means of wedge locks. A ram spacer permits the use of thin molds without bolsters.

The use of an overhead oil tank is said to eliminate contamination by dirt, water, or plastic material. Sub-plate mounted manifold valves eliminate a large percentage of the usual number of hydraulic pipe lines. The switch panel is located at the front of the machine, and all hydraulic components are readily accessible.

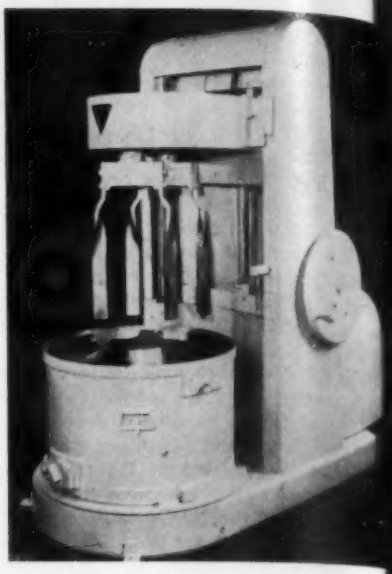


Hydraulic Press Mfg. Co.'s Model 800-H-48 injection molding machine.

Readers' Service Item E-2

Vertical Change-Can Mixer

Cincinnati Hildebrand Co., Inc., has announced the availability of a new machine for the production mixing of paints, wood fillers, chemicals, plastisols, and plast latices. Called the Double Paddle Chan Can Mixer, the unit comes in two mode and in capacities ranging from 8-12 gallons.



Cincinnati Hildebrand's production mixe

The 8-, 15-, 40-, and 50-gallon capaciti have a vertical-raising head, whereas th 80-, 100-, and 125-gallon sizes have tilti heads. The mixer is equipped with a sp cial scraper positioning device which rid along the edge of the can as it rotate on the mixer platform. Material is force from the inside edge of the can into th mixing orbit of the unit's double paddl agitators. Extending to the bottom of th can, the agitator blades also force th material up from the bottom.

Advantages claimed by the manufacture include: faster wetting, faster mixing, few cans per production run, and less sever grinding. Other features of the new mixe are: easily-operated handwheel for raisi head; anti-friction roller bearings through out; completely enclosed unit; heavy bronz thrust plate; convenient lubrication; an independently-mounted motor for ease o maintenance.

Dimensions for the 80-, 100-, and 12 gallon assemblies are as follows: width 44 inches; depth, 69 inches; height, 61 inches; and tilted height, 79 inches.

Readers' Service Item E-3

Injection Molding Machine

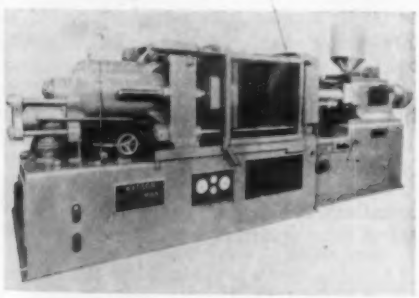
A 24-ounce horizontal injection molding machine, designed to give faster cycles and higher plasticizing rates, has been introduced by the Watson-Stillman Press Divi sion, Farrel-Birmingham Co., Inc. The heating cylinder for the new unit fea tures an internally-heated torpedo with four-zone heat control, and the injection

plunger is pre-positioned so that the mold is filled immediately after the dies are clamped. Both pressure and speed of the injection stroke are adjustable in stepless fashion, and a stuffing arrangement increases the maximum shot capacity by approximately 40%.

Improved base design is said to give better access to the pumping unit and piping. An Oilgear pumping system is employed, which consists of a radial piston-type pump connected to a 60-hp., 1,200-rpm. motor. Unloading control reduces the pump stroke, maintaining the preset pressure without excessive heating or power loss.

The "24" is designed to permit future installation of a preplasticizing unit, which will increase the capacity to 90 ounces. A self-compensating hopper and feeder are included as standard equipment. Specifications are reported as follows:

Hopper capacity, lbs.	300
Maximum ounces/shot (styrene)	24
Injection rate, cu. in./min.	1,800
Die speed, forward & return, in./min.	675
Injection speed, forward, in./min.	174
Return	400
Injection plunger stroke, in.	14.5
Injection pressure, psi.	20,000
Clamping capacity, tons	425
Distance between platens, max., in.	40
Die thickness, min., in.	16
Die sizes, max., ins.	27x45, 25x40.5
Floor space required, ins.	21x78
Over-all height, in.	102

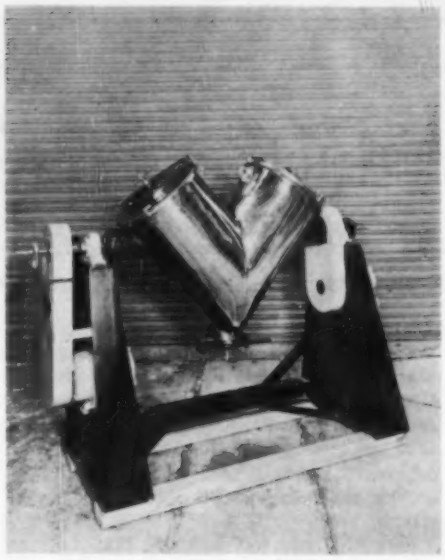


Watson-Stillman's 24-ounce injection molding machine.

Readers' Service Item E-4

Liquid-Feed Blender

A new commercial blender for the one-step mixing of dry and liquid materials has been placed on the market by Patterson-Kelley Co. Based on the firm's P-K Twin Shell Blender, the unit includes a radically different feed which is said to provide a more even blend in a much shorter time.



Patterson-Kelley's improved liquid-feed blender.

The basic design change involves the intensifier bar, a cylindrical shaft used to agitate the material during rotation. Being hollow, it was decided to pipe the liquid through the bar and direct it through a nozzle against both sides of the offset disk. Adjustable sleeves on each side of the disk protect against clogging of the opening and, depending on the viscosity of the liquid, allow for a variable rate of flow. The disk, set at an angle to the bar, sends out a fine spray of liquid as it cuts its wide swath through the dry material.

The intensifier bar was further modified by stringing ⅛-inch thick, stainless steel wires horizontally along the bar. From 8-16 in number, these wires break up any clumps which might form. The bar rotates at speeds up to 1,500 rpm., and the wires have a maximum peripheral speed of 2,000 feet per minute.

Average blending time for materials that formerly required several hours is now estimated to be 10-15 minutes. Extremely viscous liquids may require half an hour. By varying the speed of rotation or size of the wires, it is possible to control particle size. Special adaptations such as an intensifier bar studded with pins can be used for coarse, granular material. Plastic shells, transparent or otherwise, can be used for amalgamation and the handling of corrosive materials.

The new unit is particularly effective in the blending of a plasticizer with pulverized plastic material. The high viscosity of the plasticizer makes heating necessary, and the P-K Blender will accommodate liquids heated up to 250° F. The improved blender is available in 3-50 cubic foot capacities at a cost of approximately 25% more than standard models.

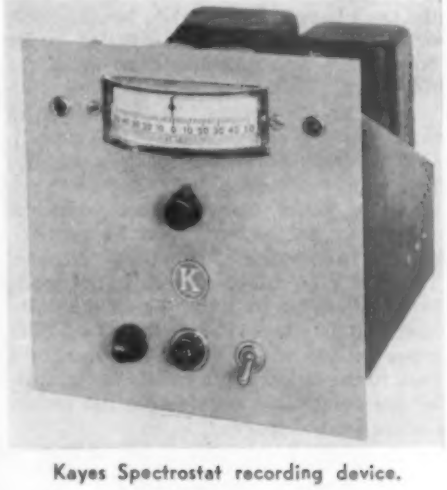
Readers' Service Item E-5

Quality Control Instruments

Instruments which measure the wavelength absorption from a continuous flow of gases, liquids, slurries, or unit solids, thereby affording a measure of quality control in plastics manufacturing, have been introduced by Kaye Development Co. Called Spectrostats, the units indicate contamination or a change in component concentration by means of a change in absorption bands.

Continuous sampling is provided throughout a production run, and the direction of deviation beyond the set limits is brought out by a visual and/or audible warning. A 50-millivolt proportional output provides direct process control. Spectrostats operate by splitting the beam between two or more detectors of different spectral sensitivity, thereby making it possible to monitor color and turbidity for two or more components of a stream. Observations may be made in the range from ultra-violet through near infra-red.

Spectrostats are supplied in standard and explosion-proof housings. Calibration is in parts per million, and the sensing elements may be operated remotely from the indicating unit. Each indicator may utilize information from several sensing units located along the product flow stream. Applications are said to include: control of process factors, pipeline batch metering, automatic mixing of additives, detection of water vapor in gas, automatic replenishing, product sorting, and titration.



Kayes Spectrostat recording device.

Optical head pickup unit for Spectrostat.

Readers' Service Item E-6

New Products

Write item numbers on Readers' Service Card to obtain more information.

Luria-Cournand's Skim Boat features reinforced plastic construction.

Reinforced Plastic Aquaplane

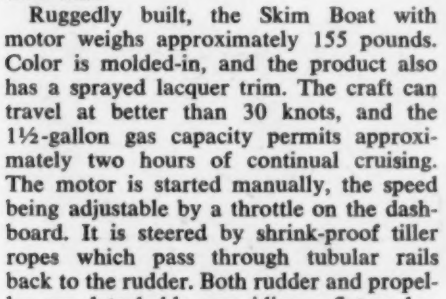
A self-propelled, unsinkable aquaplane of fibrous glass-reinforced polyester resin and honeycomb has been developed by Luria-Cournand, Inc. Called the Skim Boat, the craft is powered by a 7-, 10-, 12-, 15-, or 20-hp. outboard motor installed in the bow, which automatically shuts off if the rider falls.

Ruggedly built, the Skim Boat with motor weighs approximately 155 pounds. Color is molded-in, and the product also has a sprayed lacquer trim. The craft can travel at better than 30 knots, and the 1½-gallon gas capacity permits approximately two hours of continual cruising. The motor is started manually, the speed being adjustable by a throttle on the dashboard. It is steered by shrink-proof tiller ropes which pass through tubular rails back to the rudder. Both rudder and propeller are detachable, providing a flat undersurface for transporting.

Readers' Service Item P-1

Plastics Calculating Chart

An inexpensive plastic plus-minus calculating chart, designed to perform the same functions as the more elaborate slide rule calculators, has been developed by Charles F. Herbstreith Co. The chart is intended for use by engineers, designers, tool makers, production technicians, and others whose activities involve figuring in inches, millimeters, and decimals of either system.

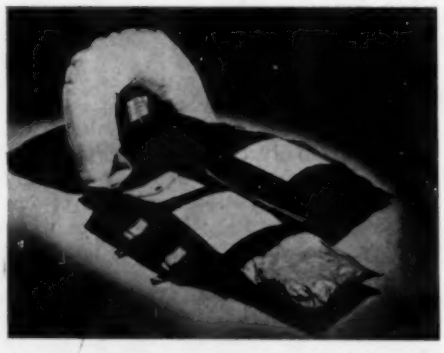


Herbstreith plus-minus plastic calculator.

Copyrighted by William Doring, of Brooklyn, N. Y., the simplified calculator consists of seven circles of figures; five sets being on the master chart, and two sets on an over-riding disc. The four inner circles enable the user to convert from the inch system into millimeters and decimals thereof, while the three outer circles permit calculations from the metric to the inch system.

The heavy plastic base is press- polished, resistant to oil, dirt, and acid, and measures 4⅞ by 3⅜ inches.

Readers' Service Item P-2



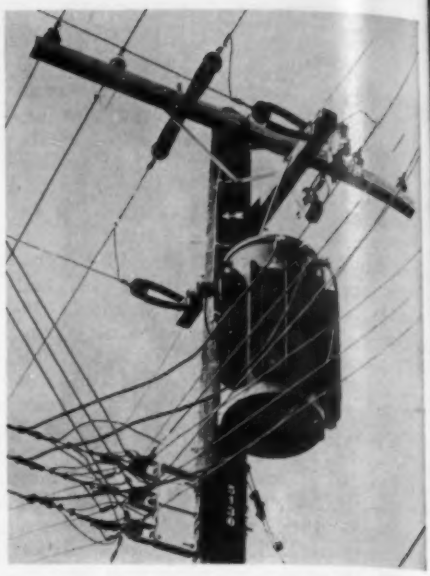
Opened life-jacket reveals polyethylene-encased kapok filler.

Film-Encased Kapok Life-Jackets

Polyethylene film reportedly is proving ideal for use in the kapok life-jackets produced by Billy Boy Products, Inc. The jackets normally become water-logged after extensive use; however, waterproof polyethylene film casings preserve the kapok and give longer life with safer operation.

Visqueen polyethylene film, a product of Visking Corp., is used for both the inner liner and the outer bag. Packaging of the finished product is also in polyethylene film, which permits the bright colors of the jacket to show through, and thus increase salability.

Readers' Service Item P-3



Polyethylene pipe housing (arrow) for primary cable.

Polyethylene Pipe Housings

Electrical power and telephone wires mounted on outdoor poles are being protected against impacts and damage by climbing linesmen through the use of polyethylene pipe. As illustrated in the accompanying photograph, the pipe is used to house a lead from a primary cable on the pole cross-arm to the secondary transformer.

The pipe is extruded from Bakelite polyethylene by Triangle Conduit & Cable Co., Inc., in diameters from ½-6 inches, and in 100 or 300-foot coils. Insert fittings molded from Bakelite high-impact styrene are available to affix the pipe end with a screw clamp to form a coupling, T-joint or elbow, or to connect to metal pipe.

Other similar uses for the pipe include protection for ground wires, secondary wiring for a network installation, and an overhead to underground service run. As a housing for the lead from an insulating transformer down to the bracket of a pole-mounted street light, mounted under a pole cross-arm, the pipe protects non-metallic sheathed cable and keeps the secondary wires from interfering with standing room.

Readers' Service Item P-4

Thoxene epoxy coating to a cable splice.

Epoxy Cable-Splicing Formula

A hard-setting epoxy compound, based on Shell Chemical's Epon resins, has been developed by Woodmont Products, Inc., for rapid field insulation and weatherproofing of electrical cable splices, and as an impervious sealant for gas lines. Designated Thoxene Clamp-Coat, the compound is packaged in a compartmentalized polyethylene container, in which the base formulation and activator are separated by metal clips.

The components are colored blue and yellow, and completeness of mixture is assured when a uniform green is obtained. The cable splice is covered and allowed to harden for 2½-3 hours, depending on the ambient air temperature. Coatings up to ⅛-inch thick can be applied without dripping, and each packing holds enough material to coat six ⅜-inch clamps or three ¼-inch wire clamps.

Readers' Service Item P-5

Vinyl laminate split to form two insoles.

Porous Vinyl Laminate Insole

A long-wearing shoe insole, reportedly corresponding in porosity to the sole of the foot, has been introduced by United Shoe Machinery Corp. Called Poron, the insole is made by laminating a layer of porous Bakelite vinyl resin between two layers of latex-impregnated backing. The sandwich is then split in half to form two insoles, the porous layer being used uppermost for contact with the foot.

Seven months' testing showed conventional insoles to absorb sufficient moisture to cause brittleness, cracking, and loss of flexibility. Poron insoles remained soft, resilient, and unbroken during the same period of use. Vinyl insoles are 20-40 times more porous than ordinary insoles, according to the manufacturer, and thus eliminate absorbed moisture many times faster.

Readers' Service Item P-6

Radio-Phono Extension Speaker

An "Extra Voice" speaker manufactured by Holiday Plastics gives radio and phonograph fans the enjoyment of a second set at a fraction of the original cost. Standing about five inches high and weighing only two pounds, the speaker is housed in a tough, scratch-resistant cabinet of Boltaron 6100. This styrene-butadiene-acrylonitrile copolymer, compounded by Bolta Products, was reportedly chosen due to its attractive grain appearance, ease of fabrication, and low tooling costs.

The cabinet has a radio type grill and two control knobs regulating both tone and volume. The new speaker is particularly suitable for hospitals, hotels, and motels, as well as play and bedrooms.

Holiday's Extra Voice radio and phonograph speaker.

Readers' Serice Item P-7

"Colloid Corner" by COLUMBIAN

Plastics that don't get "SUNBURN"

Protect your polyethylene pipe and cable from "sunburn" with Columbian's colloidal carbon

- Columbian's #999 offers maximum efficiency and economy.
- For greater jetness Columbian's Superba® is preferred.
- Whatever you need, Columbian has the right carbon black.
- Consult us about your application or send for technical information.

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New Literature

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"New Developments in Mylar Polyester Film." No. 3, dated November 1955. E. I. du Pont de Nemours & Co., Inc. 24 pages. This issue contains illustrated stories on styling effects with metallized Mylar film; decorative yarns made of Mylar; dyeing process for Mylar; properties of Mylar; and industrial applications of the film.

Readers' Service Item L-1

"Catalin Cast Resins for Photoelastic Analysis of Stress." Catalin Corp. of America. 4 pages. Special materials, such as Catalin 61-893, are required for photoelastic stress studies according to this report. Annealing, machining, milling, and other finishing operations are described, along with the theory of making a frozen pattern.

Readers' Service Item L-2

"Plasticizers." Ohio-Apex Div., Food Machinery & Chemical Corp. 71 pages. Each of the company's plasticizers is described in terms of formula, molecular weight, specifications, average properties, suggested uses, and shipping containers. An introductory section discusses the compounding of plasticizers, heat and light stabilizers, and colorants for plastics.

Readers' Service Item L-3

"Money Making Performance in Extrusion." Abaco Industries, Inc. 4 pages. The use of extrusion in the plastics industry is discussed, and information given on the design of the company's extruders, including drive and transmission, cylinder and liner, screw, motor, electrical equipment and controls, head, feed hopper, and accessory equipment. A table of specifications of Abaco extruders is included.

Readers' Service Item L-4

"Du Pont Mylar Polyester Film." Film Dept., E. I. du Pont de Nemours & Co., Inc. 8 pages. Detailed physical and chemical properties of Mylar are tabulated in this booklet, together with descriptions and photos of the latest commercial uses of the film.

Readers' Service Item L-5

"Melamine Molding Compound 3136." American Cyanamid Co. 5 pages. Information given on 3136, a glass fiber-filled melamine-formaldehyde molding material, includes distinctive properties, applications, storage and handling, preforming, preheating, shrinkage, molds, molding, and finishing. Tentative characteristics of the compound and physical properties of moldings are tabulated.

Readers' Service Item L-6

"Naugatuck Plastics Condensed Catalog 1955-1956." Naugatuck Chemical Division, United States Rubber Co. 12 pages. Property data and other technical information on the firm's Kralastic rubber-resin blends, Marvinol vinyls and plasticizers, and Vibrin polyester resins are given in chart form along with photographs of numerous applications.

Readers' Service Item L-7

"IC Polyester Resins." Finishes division, Interchemical Corp. 21 pages. The company's resins and other polyester products used in hand lay-up and surface finishing of boats and swimming pools, and in bag molding, vacuum molding, and casting, are described in a series of technical bulletins. These bulletins are enclosed in a folder which carries charted catalog data.

Readers' Service Item L-8

"Epoxidation and Hydroxylation with Becco Hydrogen Peroxide and Peracetic Acid." Bulletin No. 69. Becco Chemical Division, Food Machinery & Chemical Corp. 49 pages. Reactions of unsaturated olefins derived from agricultural and petroleum products are given, along with descriptions of two new "in situ" epoxidation processes. Advantages of hydrogen peroxide or peracids and oxidants in organic synthesis, and safety measures, process equipment, and uses of epoxy compounds are covered. Also included is a nine-page conversion table for rapid calculation of the following: moles of ethylenic unsaturation in a raw material of a given iodine or bromine number; oxidant requirements for epoxidation or hydroxylation; and percent of oxirane oxygen or hydroxyl in the resultant product.

Readers' Service Item L-9

"Program for Engineering Education in Plastics." Society of Plastics Engineers, Inc. 11 pages. This report of a study undertaken by the Education Committee of the Society presents an integrated program and curricula for engineering education in polymeric materials and their processing. Schools offering courses along these lines are listed at the back of the booklet.

Readers' Service Item L-10

"Para Coumarone Indene Resins." Bulletin 12-64. Harwick Standard Chemical Co. 6 pages. Melting points, colors, and forms for the firm's Piccoumaron para-coumarone indene resins are listed, along with compatibility data, formulations, and applications.

Readers' Service Item L-11

"Seven Marvinol PVC Resins." Naugatuck Chemical Division, United States Rubber Co. 4 pages. Resin and compound properties for the firm's VR-series Marvinol vinyls are presented, along with a description of special features.

Readers' Service Item L-12

"Becco Hydrogen Peroxide SP 100." Bulletin No. 70. Becco Chemical Division, Food Machinery & Chemical Corp. 7 pages. Hydrogen peroxide solutions ranging in concentration from 90-100% have been prepared by Becco using a continuous fractional crystallization process. Physical properties and information on the stability, solubility, energy content, hazards, shipping, and analysis of 90, 95, and 100% concentrations are included.

Readers' Service Item L-13

"Exon Marks the Spot." Firestone Plastics Co. 4 pages. Four vinyl resins are described briefly in the light of their applications.

Readers' Service Item L-14

"Barrett Standard Industrial Chemicals, 1956." Barrett Division, Allied Chemical & Dye Corp. This catalog of the company's chemicals gives a description of the composition and properties of each material, together with information on applications and packaging. Chemicals covered include tar acids, tar acid oils, phthalic anhydride, maleic anhydrate, fumaric acid, plasticizers, Cumar resins, Resin S, rubber compounding materials, naphthalene, tar bases, niacin, acetone, glycols, ethanolamines, aromatic industrial solvents, and others.

Readers' Service Item L-15

Book Reviews

"Handbook of Industrial Statistics." Albert H. Bowker and Gerald J. Lieberman. Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N. Y. Cloth, 6 by 9 inches, 204 pages. Price, $5.00.

This volume is a reprint of a section on industrial statistics appearing in the "Handbook of Industrial Engineering and Management," and has been published separately to serve as a useful and convenient tool for engineers, statisticians, and teachers of courses in industrial statistics. Since the presentation covers statistics as a science for making decisions, the book should be of special value to physical scientists.

Detailed explanations are given of the most commonly used statistical techniques, together with adequate tables for use in applying the techniques. Each section of the book begins with a concise explanation of the practical value of the information given therein. After briefly discussing descriptive statistics, the authors present comprehensive information to serve as a guide in solving production problems.

The section on sampling inspection includes discussions of drawing the sample; various sampling plans; designing the attribute plan; and lot-by-lot sampling inspection by variables. The section on common significance tests judges these tests from the standpoint of the risks they involve, and gives complete operating characteristics for use in desiging experiments. Similar useful and complete discussions are given on curve fitting and the analysis of variance.

"Development of Room-Temperature-Curing Structural Adhesives for Metals." Bjorksten Research Laboratories, Inc. Order PB 111764 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 89 pages. Price, $2.25.

Metal-to-metal adhesives requiring little curing temperature are discussed in this report for the U. S. Air Force. Test procedures are described, which led to the development of a room-temperature, low-pressure curing adhesive suitable for the fabrication and field repair of certain airframe structural parts.

Designated P-262A, the material consists basically of methacrylic acid and methyl methacrylate. It possesses properties comparable to those required by MIL-A-8331. Formulation and processing is described, along with a properties analysis. Also covered in the report are details on the preparation of aluminum surfaces prior to bonding. A supplemental report, PB 111746S, concerns additional investigations to improve the short pot life and open assembly time of P-262A. The report bears the same title, and sells for $1.25.

"Research on the Preparation and Properties of High-Temperature Resistant Copolymers." George Washington Carver Foundation for Wright Air Development Center. Order PB 111765 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 23 pages. Price, 75¢.

Para-dichlorobenzene and alkali metals were reacted in the presence of various unsaturated compounds in an attempt to develop heat resistant copolymers. Among the unsaturated compounds used are: vinyl acetate, ethylene, isobutylene, methyl acrylate, acrylonitrile, and 1,3-butadiene.

Polymers with melting points above 250° C. were obtained from each of these reactions, and it was concluded that the copolymer molecules contained rigid segments of phenylene units interspersed with flexible carbon-carbon chains. In these copolymers the properties of polyphenyl, an infusible material, are modified by those of the vinyl polymers.

"The Effect of Storage on Shoe Threads." Edward B. Frederick and Walter Zagieboylo. Order PB 111976 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 31 pages. Price, $1.00.

This report on the efficacy of nylon and polyester threads for military shoe manufacture is based on laboratory tests, conducted by the Army Quartermaster Research & Development Command. Stress-strain properties of the threads were evaluated at six-month intervals over a period of two years, during which time they were subjected to controlled tropical heat and moisture. The threads were stored in skein form wrapped around sole leather swatches, and in seams.

Cotton and linen threads, stored under the same conditions, were found to have lost more of their strength than the synthetic fiber threads. The results of these laboratory tests are being checked in field tests.

"The Van Nostrand Chemist's Dictionary." Edited by J. M. Honig, M. B. Jacobs, S. Z. Lewin, W. R. Minrath, and George Murphy. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. Cloth, 6 by 9 inches, 765 pages. Price, $10.

Planned to meet the needs of the chemist and engineer, this dictionary contains more than 11,000 definitions of laws, equations, reactions, tests, solutions, laboratory apparatus, industrial processes, and equipment. Items are listed under both their proper names and common names for quick identification. The definitions are in accordance with the latest ACS nomenclatures, and are systematically organized under a Key Word Plan that helps in cross-referencing the subjects. Under this Plan, every word in a specific definition that is further defined elsewhere in the book is printed in bold-face type. This Plan permits the reader to correlate all information from the various sciences on a specific point, thus providing a well-rounded, integrated knowledge of the subject.

"Chemical Trade Names and Commercial Synonyms." Second Edition. William Haynes. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y. Cloth, 6 by 9 inches, 472 pages. Price, $8.

Containing more than 25% more entries than its predecessor, this revised and enlarged edition presents precise and complete definitions of the special names used in the chemical industry. All definitions have been brought up to date, and cover abbreviations adopted to simplify the long technical names of the newer organic compounds, as well as terms coined by manufacturers.

The only dictionary of its kind available today, this volume should be of value to chemists, manufacturers, purchasing agents, and all others dealing with industrial chemicals.

"Research on Boron Polymers, Part II." Rutgers University for Wright Air Development Center. Order PB 111892 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 85 pages. Price, $2.25.

This report covers 18 months of research on boron polymers in an attempt to develop thermally-stable plastics and elastomers which are also oil- and fuel-resistant. The project was directed primarily toward the synthesis of quadricovalent chelate and quasi-chelate boronic acids and borates. The diethanolamine ester of benzene-boronic acid proved stable to hydrolysis, and could be recrystallized from water. Allylboronic acid and its esters also were synthesized and studied.

"Curing of Void-Free Glass-Cloth-Reinforced Laminates at Room Temperature." Forest Products Laboratory, U. S. Department of Agriculture, for Wright Air Development Center. Order PB 111823 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 35 pages. Price, $1.00.

This report points out that many oxygen-liberating catalysts will promote resin cure at room temperature; however, care must be taken to avoid too rapid or too slow curing conditions. These materials were used to promote cure in polyester resin-181 glass cloth combinations, and yielded laminates of acceptable strength properties. Durability tests have not been completed.

Abstracts of Important Articles

Materials

"Time and Temperature Effects on the Deformation of Asphaltic Bitumens and Bitumen-Mineral Mixtures," C. Van der Poel, *SPE J.*, 11, 7, 47 (Sept. 1955).

A nomograph which allows easy determination of the stiffness of bitumens as a function of time and temperature is presented. A study of all deformations shows that the stiffness of bitumen-aggregate mixtures of low voids contents is a function of only the stiffness of the bitumen they contain. As a result, a simple system can be built up for deriving the stiffness of all bitumen and bitumen-mineral mixtures.

"Will the Polyethylene Gamble Pay Off?" E. S. Childs, *SPE J.*, 11, 8, 11 (Oct. 1955).

Market applications and potentials for polyethylene are examined in light of contemplated expansions in resin manufacturing facilities.

"Recent Advances in Isocyanate Resins," Irving Katz, *SPE J.*, 11, 8, 16 (Oct. 1955).

Development in isocyanates for use in elastomers, isocyanate-modified polyesters, and internally plasticized polyurethanes; polyurethane, hybrid polyurethane-polyurea, and polyisocyanate adhesives; potting compounds; greases; rocket propellants; expanded plastics; heat-resistant plastics; isocyanate-treated boron-base polymers; and isocyanate-treated silicon-base polymers.

"Use the Right Material," J. H. DuBois, *SPE J.*, 11, 8, 26 (Oct. 1955).

Guides are given to aid in the selection of plastic materials for proper application.

"Properties of Styrene-Polyester Copolymers," James M. Church and Conrad Berenson, *Ind. Eng. Chem.*, 47, 12, 2546 (Dec. 1955).

Maleic anhydride and triethylene glycol were polymerized to varying degrees, as represented by acid numbers of 25-100. These polyesters then were copolymerized with 8-31% by weight of styrene. Correlations established between the chemical composition and the physical and chemical properties of the resulting copolymers indicate that polyesters with acid numbers in the range of 25-50 produce better surface coating and casting resins.

"Torsional Properties of Plastics," E. B. Sharp and Bryce Maxwell, *Modern Plastics*, 33, 4, 137 (Dec. 1955).

Test results on torsional behavior and tensile tests on cellulose acetate, cellulose acetate butyrate, polystyrene, methyl methacrylate, and wood flour-filled phenolic indicate that these tests supply the data needed to determine the elastic constants of these materials. The theoretical and actual values of these constants are compared at various temperatures.

"Sizing Pipe for Flow of Cellulose Acetate Solutions," F. L. Symonds, A. J. Rosenthal, and E. H. Shaw, *Ind. Eng. Chem.*, 47, 12, 2463 (Dec. 1955).

Mathematical formulas are given to show the relationships between shear stress and rate of shear at the pipe wall for solutions of cellulose acetate in acetone. Pipeline and rotational viscometer data, flow equations, and nomographs for solving pipe flow problems are also expressed.

"Permeability of Polymer Films to Gases and Vapors," Richard Waack, N. H. Alex, H. L. Frisch, Vivian Stannett, and Michael Szwarc, *Ind. Eng. Chem.*, 47, 12, 2524 (Dec. 1955).

Data on the transmission of gases through polymer films is given; including experimental procedures, permeability constants, and factors influencing these constants. Amorphous polymers are shown to have higher permeabilities than crystalline polymers; however, molecular symmetry, degree of cross linkage, and cohesive energy density are influencing factors.

"Irradiation of Plastics with High Energy Electrons," P. Namur, *Kunststoffe*, 45, 10, 421 (Oct. 1955).

The effect of isotopes for irradiating plastics is compared with that of accelerator apparatus. Four different types of the latter are described, the linear electron accelerator being considered as the most promising for practical applications. Dosage and structural changes in plastics caused by irradiation are considered, and the economics of the process discussed. (In German.)

"Allyl Polymerization Beyond the Gel Point," Howard W. Starkweather, Jr., and Frederick R. Eirich, *Ind. Eng. Chem.*, 47, 12, 2452 (Dec. 1955).

Unit refraction was used to follow the polymerization of diethylene glycol bis (allyl carbonate) beyond the gel point. Ultimate conversion and rate of polymerization were found to exceed 70% regardless of the amount of initiator used. Results indicate a decline in the importance of degradative chain transfer as a kinetic chain terminating step beyond the gel point.

Equipment

"Evaluation of the Boor-Quartermaster Snag Tester for Coated Fabrics and Plastic Films," F. W. Reinhart, Catherine Brown, Ladislav Boor, and J. J. Lamb, *ASTM Bull.*, No. 210, 50 (Dec. 1955).

Data are given on the design, operation and use of the tester, which determines snag resistance by three observations; angle of elevation of the needle for tear, energy to tear, and type of tear. The method is recommended for testing coated fabrics and plastic films, but not for uncoated fabrics.

"High-Speed Tension Testing Machine for Plastics," James Dorsey, F. J. McGarry, and A. G. H. Dietz, *ASTM Bull.*, No. 211, 34 (Jan. 1956).

An apparatus is described which records stress-strain data during a tension test that consumes 5-15 milliseconds from start of loading to fracture. The permanent record of strain information is made by oscilloscope camera.

"Mold Design for Effective Temperature Control," C. H. Whitlock, *SPE J.*, 11, 10, 25 (Dec. 1955).

The effects of mold material and design on controlling temperature during molding, with emphasis on channeling and use of cold water.

"Prehardened Mold Steels for the Plastics Industry," B. L. Johnson, *SPE J.*, 12, 1, 37 (Jan. 1956).

The advantages that can be gained by use of prehardened steels for molds are discussed.

"Polyliner Improves Injection Molding," E. C. Bernhardt and L. Paggi, *Modern Plastics*, 33, 6, 109 (Feb. 1956).

Details on a new device which can replace the conventional torpedo in injection cylinders. This device increases molding speed, reduces pressure drop, and improves the quality of molding.

Processing

"Varnishing Semi-Finished and Finished Plastic Goods," W. Oltze, *Kunststoff-Rundschau*, 2, 10, 360 (Oct. 1955).

The basic prerequisites for effective surface treatment of plastic goods by the most usual methods are discussed. Special attention is given to the requirements for color decorating, and metallizing of surfaces. (In German).

"The Development of Rigid Vinyl Sheet Production," F. B. Makin, *Brit. Plastics*, 28, 12, 500 (Dec. 1955).

After reviewing the early work on the production of rigid vinyl sheet, the author takes up the manufacture of Cobex sheet from the formulation, through the pre-mixing, milling, calendering and surfacing operations and equipment, production control, and inspection. Mention is made of stabilizer-lubricant systems and colorants used for this material, and a heat-stability test for colorants is described.

Applications

"Vinyl Resins in Adhesives," E. Cernia and A. Bonvicini, *Materie Plastiche*, 21, 11, 929 (Nov. 1955).

After explaining the structure of polyvinyl acetate and its uses in adhesives, the authors discuss copolymers of vinyl chloride and vinyl acetate, vinyl chloride and acrylic esters, vinyl chloride and vinylidene chloride, and polyvinyl alcohols, acetals, and ethers. (In Italian).

"Plastics-Paper Combinations," E. C. Jahn and V. T. Stannett, *SPE J.*, 12, 1, 32 (Jan. 1956).

A review of types of plastics-paper combinations and their methods of application.

"Industrial Applications for Dispersions of Vinyl Resins," R. L. Norum, *SPE J.*, 12, 1, 21 (Jan. 1956).

Use of vinyl dispersions in coating for machine mounting pads, and in flexible molds, foams, potting compounds, slush molding, reverse slush molding, metal decorations, and wrinkle finishes.

General

"Plastics and Resins," E. E. McSweeney and E. L. Kropa, *Ind. Eng. Chem.*, 48, 1, 22A (Jan. 1956). An annual review of developments in plastics and resins during the past year.

"Electrostatic Charges in Plastics," S. M. Skinner, Joseph Gaynor, and G. W. Sohl, *Modern Plastics*, 33, 6, 127 (Feb. 1956).

Experimental evidence is given showing that the static charges on plastics is a volume charge distribution, rather than a surface distribution. Practical applications are indicated for control of static charges on polymers and in adhesion technology.

"Fire Hazards of Clothing," V. Colebrook, *Rubber & Plastics Age*, 36, 12, 734 (1955).

Since 1951, 50% of the cases of home burns treated at the Birmingham Accident Hospital, in England, were due to easy ignition of the clothing of the victims. The need is stressed for an adequate flammability test to be adopted as standard, and the Lawson test is considered suitable for this purpose. The desirability of a standard method for testing flame-proofed fabrics for possible toxicity also is emphasized. To insure that the extra cost would not discourage parents of young children from buying safer materials, government subsidy might be needed.

"Fire Hazards of Plastics," D. I. Lawson and F. E. T. Kingman, *Plastics & Rubber Age*, 36, 11, 648 (Nov. 1955).

The fire hazards resulting from flammable solvents and dust explosions in the manufacture and processing of plastics are discussed, together with hazards involved in the use of plastics. British standard fire tests for plastic applications in the building industry, as in external coverings, separating walls, wall linings, etc., are described, as is a flammability test for thin flexible materials for packaging or wearing apparel. In the latter test, a sample is stretched over a semi-circular arched track and ignited at one end. From the distance and time of spread, the speed is derived with which flame would run vertically up a hanging material. The risks of roof lights made from corrugated plastic sheeting are mentioned, and it is pointed out that there is as yet no British Standard for this application. Finally, the toxic hazards of plastics in fires are considered, with special reference to cellulose acetate and PVC.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. The publishers and their addresses are given below:

"ASTM Bulletin"
American Society for Testing Materials
1916 Race St., Philadelphia 3, Pa.

"Australian Plastics"
Australian Trade Publications, Ltd.
171 Sussex St., Sydney, Australia

"British Plastics"
Iliffe & Sons, Ltd.
Dorset House, Stamford St.
London S.E.1, England

"Canadian Plastics"
341 Church St., Toronto, Ont., Canada

"Chemical and Engineering News"
1155 Sixteenth St. N.W.
Washington 6, D. C.

"Hule Mexicano y Plasticos"
Filomeno Mata 13-11, Mexico, D.F.

"Industrial and Engineering Chemistry"
1155 Sixteenth St. N.W.
Washington 6, D. C.

"Industries des Plastiques Modernes"
Les Publications Techniques Associees
40 Rue du Colisee, Paris 8e, France

"Kunststoffe"
Carl Hanser Verlag
Leonard Eck Str. 7, Munich 27, Germany

"Kunststoff-Rundschau"
Brunke Garrels, Verlagsbuchhandlung
Borgfelder Strasse 83, Hamburg 26, Germany

"Materie Plastiche"
Via Farneti 8, Milan, Italy

"Matiéres Plastiques"
Galerie du Center, Bloc 3
Rue des Fripiers, Brussels, Belgium

"Mechanical Engineering"
American Society of Mechanical Engineers
29 W. 39th St., New York 18, N. Y.

"Modern Plastics"
575 Madison Ave., New York 22, N. Y.

"Oesterreichische Plastic-Rundschau"
Ployer & Co.
Aegidiengasse 5, Vienna 6, Austria

"Plaste und Kautschuk"
Veb Verlag Technik
12 Unter den Linden
Berlin N.W.7, Germany

"Plastic"
Danish Technical Press
31 Vester Farimogsgade
Copenhagen 5, Denmark

"Plastica"
Kunststoffeninstituut T.N.O.
Julianalaan 134, Delft, The Netherlands

"Plastics"
Temple Press, Ltd.
Bowling Green Lane, London E.C.1, England

"Plastics World"
Cleworth Publishing Co., Inc.
22 W. Putnam Ave., Greenwich, Conn.

"Plastiques Informations"
94 Rue Saint-Lazare
Paris 9e, France

"Plastverarbeiter"
Verlagsgec. m.b.H.
Herxheim b. Landau/Pfalz, Germany

"Poliplasti"
E.T.A.S., Via Andrea Mantegna 6,
Milan, Italy

"Revista de Plasticos"
Inst. "Alonso Barba"
Serrano 119, Madrid, Spain

"Revue Générale des Matiéres Plastiques"
196 Ave. Jean-Jaures, Paris 19e, France

"Rubber and Plastics Age"
Rubber and Technical Press, Ltd.
Tenterden, Kent, England

"SPE Journal"
Security Bank Bldg., Athens, Ohio

Patent Digest

Materials

Acrylamides of N-Aminoalkyl Alkylene Ureas and Their Polymers. No. 2,727,016. Elinor M. Hankins and Sidney Malamed, Philadelphia, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

The reaction is carried out at —20 to 50° C., in the presence of an acceptor for hydrogen halides.

Polymerizable and Polymerized Aminoethyl Acrylate-Acrylonitrile Compositions. No. 2,727,021. John A. Price, Stamford, Conn. (to American Cyanamid Co., New York, N. Y.).

The composition comprises 1-20% by weight of 2-(4-morpholinyl)ethyl acrylate and acrylonitrile.

Ethylene Polymerization. No. 2,727,023. Bernard L. Evering, Chicago, Ill., Alan K. Roebuck, Dyer, Ind., and Alex Zletz, Park Forest, Ill. (to Standard Oil Co., Chicago, Ill.).

Ethylene is contacted with a supported catalyst consisting of activated carbon and 0.5-25% of a reduced cobalt or nickel oxide. The reaction takes place at 10-300° C., at a pressure of over 50 psi. The polymers are separated from the mass by solvent washing.

Phenolic Adhesive and Method of Making Same. No. 2,727,869. Jacob R. Ash and Alan L. Lambuth, Seattle, Wash. (to Monsanto Chemical Co., St. Louis, Mo.).

About 125 parts by weight of a furfural by-product residue from the acid hydrolysis of a pentosan-containing material is reacted with 300 parts water at 50-70° F. Approximately 25 parts of sodium hydroxide dissolved in 25 parts water and 25 parts of sodium carbonate are added and agitated for 20 minutes. Phenolformaldehyde resin is then added in the ratio of 500 parts by weight, and agitation continued for about 10 minutes.

Polymeric N, N'-Alkyleneureidoalkyl Acrylamides and Process for Producing Them by Aminolysis. No. 2,727,015. Robert W. Auten, Jenkintown, and Elinor M. Hankins, Philadelphia, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

A soluble polymer of a lower alkyl acrylate and an aminoalkylalkyleneurea are reacted at 65-130° C., under alkaline conditions. Amide groups are formed in the polymer.

Storable Isocyanate-Modified Polyesters. No. 2,725,366. Nelson V. Seeger, Cuyahoga Falls, and Thomas G. Mastin, Akron, O. (to Goodyear Tire & Rubber Co., Akron, O.).

A cured elastomeric composition is produced by the following steps: a material is prepared from bifunctional ingredients which include a dibasic carboxylic acid and a hydrogen-bearing amine; reacted with a diisocyanate; and a polyisocyanate is added in sufficient amount to bring the NCO-equivalent in the cured material to 2.8-3.2.

Salts of Terpolymers of Maleic Anhydride, Diisobutylene, and Divinylbenzene. No. 2,725,367. Warren D. Niederhauser, Huntingdon Valley, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

Two-three molar equivalents of maleic anhydride are reacted with 2-3 molar equivalents of diisobutylene and 0.3-5% of divinylbenzene.

Copolymers of Triphenylethylene. No. 2,725,369. Preston Robinson, Williamstown, Mass. (to Sprague Electric Co., North Adams, Mass.).

Triphenylethylene is copolymerized with a monomer such as n-vinyl carbazole, styrene, or butadiene.

Adducts of Imides and Polyisocyanates. No. 2,725,385. Nelson V. Seeger, Cuyahoga Falls, and Thomas G. Mastin, Akron, O. (to Goodyear Tire & Rubber Co., Akron, O.).

An imide is selected from the group consisting of carbimide, succinimide, glutarimide, phthalimide, and naphthalimide, and reacted with an organic polyisocyanate. The isocyanate must be free from groups containing active hydrogen.

Copolymers of an Unsaturated Polyester and Acrylonitrile. No. 2,723,967. Walter M. Thomas, Springdale, Conn. (to American Cyanamid Co., New York, N. Y.).

The copolymer consists of acrylonitrile and bis(2-diethylaminoethyl) fumarate in the proportion of 5-100:1, by weight.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Colored Composition of Vinyl Chloride Resins. No. 2,725,365. William E. Leistner and Olga H. Knoepke, Brooklyn, N. Y. (to Argus Chemical Laboratory, Inc., New York, N. Y.).

The compound consists of a vinyl chloride resin with a nickel salt of dimethyl glyoxime added as a colorant.

Production of 1,1-Difluoro-2,2-Dichloroethylene. No. 2,723,297. Irving Litant, Flushing, and Charles B. Miller, Lynbrook, N. Y. (to Allied Chemical & Dye Corp., New York, N. Y.).

A vaporous mixture of 1,1-difluoroethylene and 0.5-2 molecular proportions of chlorine is subjected to a temperature of 550-700° C. in the presence of dichlorodifluoromethane.

Preparation of Styrene and Benzene from Acetylene and Vinylacetylene. No. 2,723,299. Manzo Tanaka and Kazumi Yamamoto, Omuta-shi, Fukuoka-ken, and Mitsuo Oku, Tamana-gun, Kumamoto-ken, Japan, (to Mitsui Kagaku Kogyo Kabushiki Kaisha, Tokyo, Japan).

Acetylene and monovinylacetylene, in the molar ratio of 1.5-20:1, are heated 40-150° C. under a pressure of 70-700 psi., and in a solvent such as benzene, acetonitrile, or tetrahydrofuran. Triphenylphosphine nickel-bicarbonyl is used as a catalyst.

Method and Composition for Inhibiting Foam in Aqueous Liquids. No. 2,732,959. Arthur L. Jacoby, Western Springs, Ill., and George W. Luvisi, Chicago, Ill. (to National Aluminate Corp., Chicago, Ill.).

Foams are inhibited by adding an emulsion of water; a polyacylated polyalkylene polyamine; a water-immiscible thinner in which polyamine is at least partially soluble; and an amine salt.

Tertiary-Butyl Ethylene in Ethylene Polymerization. No. 2,728,752. Herbert C. Brown, West Lafayette, Ind. (to Standard Oil Co., Chicago, Ill.).

Ethylene is polymerized at a temperature between 40-175° C., at an elevated pressure, and in the presence of a free-radical-initiator catalyst. Tertiary butyl ethylene is used as a polymerization modifier.

Equipment

Method and Apparatus for Shell Molding. No. 2,728,122. Thomas J. McLeer, Elizabeth, N. J. (to Cooper Alloy Corp., Hillside, N. J.).

An accessory, designed to be mounted in a power press for use with shell mold parts, is described as consisting of a bottom plate and a mating top plate. One or both of the plates have a number of compression springs projecting toward the other plate, so arranged as to bear at many points against the non-cavity portion of shell mold parts. These parts are pressed together, and permanently adhered to the metal pattern parts.

Extrusion Press. No. 2,728,453. Hardin D. Thweatt, Buffalo, and Carl G. Swanson, Kenmore, N. Y. (to Lake Erie Engineering Corp., Buffalo, N. Y.).

The metal extrusion press has a die platen with an opening through which the extrusion is projected. The cylinder platen, which carries the main cylinder, has a main ram with a plunger which can be projected toward the opening. A billet container holder, interposed between the platens, is movable parallel with the axis of the plunger and opening. The die can be moved in and out of coaxial relation to the axis, supported by a swinging arm. The die holder is compressed against the die platen, and released to accomplish extrusion.

Extruder. No. 2,725,596. Harold Weber, Bloomfield, N. J. (to Celanese Corp. of America, New York, N. Y.).

The extruder consists of a chamber; a communicating, heated jacket; a rotatable screw for conveying the thermoplastic material through the jacket; and a means for supplying uniform pressure.

Preform Machine. No. 2,725,601. Ivan G. Brenner, Newark, O.

The machine has a base section for mounting the forming chamber; a reciprocable table mounted for movement in the base section; a means for discharging fibers into the chamber; a rotatable turn-table mounted within the table; a perforated form; a means for creating a vacuum, whereby fibers are caused to adhere to the form; fan; and motor.

Molding Fastener. No. 2,725,609. Robert E. Ross, Lexington, Mass. (to United-Carr Fastener Corp., Boston, Mass.).

The device consists of a molding-engaging portion formed by a pair of superimposed cross plates with aligned openings. An axle rotates the plates, and springs bias them in a predetermined angular relationship so that the over-all height of the molding-engaging portion is as great as possible. The device is intended for moldings which have inturned edges forming opposing recesses.

Apparatus for Heat Sealing and Severing Thermoplastic Material. No. 2,725,699. Herbert Rumsey, Jr., Rochester, N. Y. (to Glaz-Wrap Packaging Co., Passaic, N. J.).

The apparatus comprises: a base member; means for supporting thermoplastic sheet; a wrapping platform; a heat-sealing and severing platform; an elongated, heat-severing member; and a sheet retracting and elevating mechanism in the form of a counterweighted, pivotally-mounted member.

Device and Process for Preparing Melamine. No. 2,727,037. Carroll A. Hochwalt, Clayton, Mo. (to Monsanto Chemical Co., St. Louis, Mo.).

A melamine precursor is subjected to a temperature of 300-600° C., and a pressure of at least 700 psi., in a pressure-resistant metal reactor. This reactor has a five-mil continuous coating of a phosphorous compound, which is substantially non-fusible at the above-mentioned temperatures, on those surfaces which are exposed to the conversion products.

Jarring Apparatus for Molds. No. 2,726,428. Raymond H. Wiehsner, Philadelphia, Pa. (to Tabor Mfg. Co., Philadelphia, Pa.).

The apparatus in question is a vertically reciprocable part, which jars the mold supporting member and causes it to ram the mold. An elongated locking element with tapered end portion is carried by the part, actuating it through contact with the mold supporting member.

Processing

Process of Dyeing Polyethylene Terephthalate Fiber. No. 2,727,803. Oleta S. Larson, Mendenhall, Pa. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The fibers are treated with an azo-diaryldiamine and 2,3-hydroxynaphthoic acid, followed by diazotization and coupling on the fiber. The improvement consists of applying the diamine, the naphthoic acid, and the nitrous acid in the order named. The treatments are made in an aqueous bath heated to over 185° F. Rinsing is interposed between the first two steps in order to remove excess diamine.

Process for Converting Fused Polyethylene into a Powder. No. 2,727,693. Robert E. Cairns, Springfield, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

The polyethylene is subjected to intensive mixing in a closed chamber, and under positive pressure. A number of rotating blades are used, operating at different peripheral speeds. Both the blades and the chamber walls are kept cool during the operation by circulating water at 35-80° F. within their hollow structures.

Method and Apparatus for Producing Prestressed Reinforced Hardened Plastic Bodies. No. 2,727,293. Frederick W. Barnett, Maurice N. Sumner, and John E. Cashman, Houston, Tex.

A hardened plastic body is stressed by having at least one reinforcing member embedded therein, and maintained at a temperature different from that of the plastic as it hardens.

Polymerization Process. No. 2,726,204. Harold F. Park, East Longmeadow, and Charles Kilbourne Bump, Hampden, Mass. (to Monsanto Chemical Co., St. Louis, Mo.).

The process for catalyzing an aqueous polymerization of substantially water-insoluble polymerizable monomers involves the application of an electric potential to two immersed electrodes. This makes the emulsion electrically conductive, and brings about electrolysis of the aqueous medium.

Process for Producing a Sand-Resin Molding Member by Vibrating. No. 2,727,431. Elbert E. Ensign, Ypsilanti, Royal Arch Van Patten, Garden City, and Julius M. Bleuenstein, Detroit, Mich. (to Ford Motor Co., Dearborn, Mich.).

Metal molding members are obtained by heating a metal pattern to a temperature of at least 350° F.; energetically vibrating the pattern; and contacting it with a sand-resin mixture in which the grains are not of a uniform size. This causes part of the sand-resin mixture to flow while the resin is being cured upon the pattern. Periodically-varying pressure is exerted, whereby the surface has an average grain size smaller than that of the original mix.

Method of Rendering Polystyrene Articles Static-Free and Resulting Article. No. 2,727,831. Robert R. Dixon, Mansfield, O., and David E. Baldwin, Pittsburgh, Pa. (to Westinghouse Electric Corp., East Pittsburgh, Pa.).

The steps comprise applying to the surface of the polystyrene part a sulfuric acid solution of from 80% H_2SO_4 to 10% fuming acid concentration. The acid should be at a temperature of 55-90° C., and should not be left on the surface long enough to cause etching. This causes sulfonation of the polystyrene surface layer, leaving the main body unaffected. Alkali is then applied to produce the sulfonic acid salt of polystyrene, which is essentially static-free.

Applications

Composite Cellular Plastic Structure. No. 2,728,702. Eli Simon, Los Angeles, Frank W. Thomas, Burbank, and Lloyd A. Dixon, Jr., Los Angeles, Calif. (to Lockheed Aircraft Corp., Burbank, Calif.).

An aircraft control surface can be made by shaping a sheet-metal skin to form a hollow member of desired contour; applying a liquid cement to the internal surface; pressing a glass-cloth fabric onto the cemented surface; drying; and pouring a reactant plastic mixture into the hollow space. This plastic mixture should be one which foams-in-place and penetrates the glass cloth to form a unitary structure.

Laminated Structures. No. 2,727,843. Edgar D. Tillyer, Southbridge, Mass. (to American Optical Co., Southbridge, Mass.).

The lens combines glass and plastic components, secured together by a layer of transparent cement. This cement consists of rosin, chlorinated paraffin wax, phenyl salicylate, and polyethylene glycol methacrylate. The glass is prepared to receive the cement by applying a thin film of casein and albumin.

Domestic Production and Sales of Plastics and Resin Material, October and November, 1955

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of March and April, 1955. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Very little change is shown from the previous month's figures; however, a look at statistics one year ago reveals a very interesting fact. Production and sales are up 10–30% in every category—grand totals show an increase of approximately 25%.

	October		November	
Cellulose Plastics:[1]	Production	Sales	Production	Sales
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,659,842	1,718,955	1,374,123	1,673,413
Sheets, 0.003 gage and over	1,508,321	1,525,509	1,511,326	1,428,203
All other sheets, rods, and tubes	711,619	665,928	609,915	648,746
Molding and extrusion materials	8,373,816	8,130,545	8,394,060	8,730,489
Nitrocellulose sheets, rods, and tubes	415,240	428,007	451,304	484,404
Other cellulose plastics	384,727	433,674	642,969	616,466
TOTAL	13,053,565	12,902,618	12,983,697	13,581,721
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	19,469,839	18,049,178	19,122,245	17,979,534
Bonding and adhesive resins for—				
Laminating (except plywood)	6,356,997	4,723,738	6,143,979	4,708,612
Coated and bonded abrasives	1,429,789	1,434,465	1,364,209	1,547,468
Friction materials (brake linings, clutch facings, and similar materials)	2,238,093	1,797,646	2,211,229	1,978,137
Thermal insulation (fiber glass, rock wool)	5,191,523	5,067,218	5,124,975	5,308,691
Plywood	3,669,924	3,018,721	3,992,141	3,242,251
All other bonding and adhesive uses	3,050,264	2,545,135	3,033,871	3,021,443
Protective-coating resins, unmodified and modified except by rosin	2,462,926	2,054,933	2,492,856	2,187,316
Resins for all other uses	3,212,845	2,300,398	3,670,563	2,893,882
TOTAL	47,082,200	40,991,432	47,156,068	42,867,334
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	3,987,215	3,988,840	4,049,269	3,975,455
Paper-treating and paper-coating resins	2,462,635	2,162,067	2,067,965	1,618,217
Bonding and adhesive resins for—				
Plywood	8,579,538	8,349,510	8,651,944	8,090,290
All other bonding and adhesive uses, including laminating	2,896,102	2,590,039	2,417,609	2,365,180
Protective-coating resins, straight and modified	3,436,995	2,885,855	3,522,960	2,837,003
Resins for all other uses, including molding	8,572,810	7,704,891	8,010,403	7,444,906
TOTAL	29,935,295	27,681,202	28,720,150	26,331,051
Styrene Resins:				
Molding materials[1]	40,179,800	38,050,603	40,081,328	36,256,231
Protective-coating resins, straight and modified	8,799,833	7,946,001	9,288,551	7,951,862
Resins for all other uses	8,280,062	8,017,724	8,190,607	8,096,569
TOTAL	57,259,695	54,014,328	57,560,486	52,304,662
Vinyl and Vinyl Chloride Resins:[2]				
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for—				
Film (resin content)		7,498,327		6,855,426
Sheeting (resin content)		4,580,639		4,771,308
Molding and extrusion (resin content)		16,066,801		18,223,569
Textile and paper treating and coating (resin content)[3]		6,043,032		6,271,048
Flooring (resin content)		5,368,677		4,944,752
Protective coatings (resin content)		2,290,289		2,146,625
All other uses (resin content)		6,318,381		6,817,738
All other vinyl resins for—				
Adhesives (resin content)		2,669,976		2,944,785
All other uses (resin content)		9,835,889		9,830,814
TOTAL	62,159,385	60,672,011	62,199,548	62,806,065
Coumarone-Indene and Petroleum Polymer Resins	23,471,156	22,971,739	23,211,850	22,835,355
Polyester Resins:				
For reinforced plastics	3,630,604	3,312,141	4,080,086	3,963,140
For all other uses	231,194	100,948	361,717	397,204
TOTAL	3,861,798	3,413,089	4,441,803	4,360,344
Polyethylene Resins	39,208,150	34,616,537	40,911,329	35,630,762
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1] [4]	4,857,554	4,443,228	4,928,198	4,449,268
Protective-coating resins[5]	351,711	194,076	341,261	215,656
Resins for all other uses[6]	8,025,279	7,326,799	7,635,285	7,355,858
TOTAL	13,234,544	11,964,103	12,904,744	12,020,782
GRAND TOTALS	289,265,788	269,227,059	290,089,675	272,738,076

[1] Includes fillers, plasticizers, and extenders.
[2] Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3] Includes data for spreader and calendering-type resins.
[4] Includes data for acrylic, nylon, silicone, and other molding materials.
[5] Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6] Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

SOURCE: United States Tariff Commission, Chemical Division.

Current Market Prices

Price Changes and Additions

Adhesives

...n Adhesive VI, VIII	lb.	$3.08 /	$3.30
IX	lb.	4.25 /	4.50

Catalysts

...n Curing Agent BF3-400	lb.	4.00 /	4.50
C-111	lb.	.6225/	1.10
D	lb.	3.33 /	4.75
T	lb.	.80 /	1.11
U	lb.	.86 /	1.02
Z	lb.	1.265 /	1.56

Fillers

...rwick Walnut Shell Flours:			
100W, 200WD	ton	46.00 /	56.00
100WD	ton	40.00 /	50.00
200W	ton	56.00 /	66.00
200WB	ton	59.00 /	69.00
325W	ton	70.00 /	80.00

Lubricant

...de	20 oz.	1.25 /	2.00

Plasticizers

...mex 710	lb.	.325 /	.35
711	lb.	.345 /	.37
744, 745	lb.	.40 /	.425

Resins & Molding Compounds

Acrylic

...iglas molding powders:

Colorless	lb.	.55 /	.80
Colors, stock	lb.	.59 /	.84
Custom	lb.	.59 /	1.00

Sheets, Types I-A & II			
Colorless	sq. ft.	.80 /	22.18
Colors	sq. ft.	.88 /	1.10
Type R, Colorless	sq. ft.	.60 /	12.64
Colors	sq. ft.	.69 /	1.07

Epoxy

Epon 562	lb.	1.52 /	1.77
815	lb.	.80 /	.99
820, 828	lb.	.80 /	.97
834	lb.	.855 /	1.00
864	lb.	.91 /	1.06
864-C-75	lb.	.73 /	.85
1001	lb.	.615 /	.85
1004	lb.	.595 /	.6025
1007	lb.	.605 /	.6125
1009	lb.	.69 /	.6975

Polyethylene

Poly-Eth 1003	lb.	.45 /	.59
1004, 1005, 1007, 1008.5, 2005, 2007, 2037, 2205, 2215, 2235	lb.	.41 /	.55
3215	lb.	.35 /	.49
4005	lb.	.43 /	.57
5003	lb.	.53 /	.68

Vinyls

Geon 101, 101EP, 103EP, 202	lb.	.27 /	.45
121	lb.	.30 /	.48
126	lb.	.28 /	.46
400X110	lb.	.41 /	.59
404H1	lb.	.37 /	.55
409, 426, 427, 428	lb.	.32 /	.50
503H (polyblend)	lb.	.425 /	.525
2042, 2046	lb.	.315 /	.55
Colors	lb.	.365 /	.60
6373	lb.	.345 /	.58
Colors	lb.	.395 /	.63
6461	lb.	.325 /	.56
Colors	lb.	.375 /	.61
8372	lb.	.33 /	.565
Colors	lb.	.38 /	.615
8539, 8726	lb.	.33 /	.565
Colors	lb.	.35 /	.585
8590, 8591, 8592, 8593, 8594, 8595	lb.	2.00 /	2.75
8600	lb.	.275 /	.51
Colors	lb.	.325 /	.56
8620	lb.	.27 /	.505
Colors	lb.	.32 /	.555
8630	lb.	.425 /	.66
Colors	lb.	.475 /	.71
8640	lb.	.35 /	.585
8650	lb.	.32 /	.555
8677	lb.	.435 /	.67
8700A, 8750	lb.	.425 /	.66
Colors	lb.	.455 /	.69
8720	lb.	.605 /	.84
8737	lb.	.33 /	.565
8740	lb.	.295 /	.53
8749	lb.	.29 /	.525
8800	lb.	.44 /	.675
8801	lb.	.275 /	.51
Colors	lb.	.325 /	.56
8802	lb.	.33 /	.565
Colors	lb.	.38 /	.615
8804	lb.	.29 /	.525
8807	lb.	.45 /	.685
8809	lb.	.37 /	.605
8810	lb.	.275 /	.51
8812, 8813, 8814, 8815	lb.	.315 /	.55
Latex 151, 251	lb.	.315 /	.55
351	lb.	.34 /	.75
352	lb.	.31 /	.75
552, 450x157	lb.	.39 /	.75
576	lb.	.36 /	.75
652	lb.	.37 /	.75
Marvinols:			
NF-1005	lb.	.34 /	.625
NF-1055, 3520	lb.	.275 /	.56
NF-3020	lb.	.41 /	.645
NF-3025	lb.	.38 /	.665
NF-3040	lb.	.3375/	.6225
NF-3045, 3050	lb.	.37 /	.605
NF-3055	lb.	.285 /	.57
NF-3060	lb.	.29 /	.575
NF-3065	lb.	.30 /	.585
NF-3070, 3075, 3080	lb.	.265 /	.50
NF-3085, 3090, 3095	lb.	.29 /	.525
NF-3505, 3515	lb.	.36 /	.595
NF-3510	lb.	.34 /	.575
NF-4005	lb.	.44 /	.675
NF-4010, 4015, 4020	lb.	.42 /	.705
NF-5015, 5020	lb.	.40 /	.655
NF-5025	lb.	.33 /	.585
NF-5030	lb.	.29 /	.545
NR-6015	lb.	.39 /	.685
NR-6020	lb.	.39 /	.675
NR-7020, 7045, 7060	lb.	.50 /	.735
VR-10, 24	lb.	.30 /	.47
VR-12, 20, 21, 22, 30	lb.	.29 /	.46
VR-50	lb.	.32 /	.49

CALENDAR of COMING EVENTS

March 19
SPE Detroit Section, Rackham Memorial Building, Detroit, Mich.

March 21
SPE Chicago Section, Western Society of Engineers, Chicago, Ill.

March 21
SPE New York Section, Gotham Hotel, New York, N. Y.

March 22
SPI Report on 1957 National Conference & Plastics Exhibition, Hotel Biltmore, Los Angeles, Calif.

March 26-28
SPI Pacific Coast Chapter, St. Francis Hotel, San Francisco, Calif.

March 27
SPI & ASME Technical Conference on Reinforced Plastics for Packaging and Materials Handling, Department of Commerce Building, Washington, D. C.

March 28
Reinforced Plastics Group, SPE New York Section, Tufaro's Restaurant, Corona, N. Y.

March 28
SPE Quebec Section, Queens Hotel, Montreal, Que.

March 28
SPE Philadelphia Section, Franklin Institute, Philadelphia, Pa.

April 4
SPE Western New England Section, Bradley Field, Windsor Locks, Conn.

April 5
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

April 9
SPE Cleveland-Akron Section, Spanish Tavern, Brecksville, O.

April 11
SPE Newark Section, Military Park Hotel, Newark, N. J.

April 12
Fort Wayne Rubber & Plastics Group, Van Orman, Fort Wayne, Ind.

April 16
SPE Southern Section, Mammy's Shanty, Atlanta, Ga.

April 18
SPE New York Section, Gotham Hotel, New York, N. Y.

April 19
SPE Eastern New England Section, Hotel Beaconsfield, Brookline, Mass.

April 19
SPE Ontario Section, St. Regis Hotel, Toronto, Ont.

April 19
SPI Southern California Chapter, Annual Business Meeting, Scully's Restaurant, Los Angeles, Calif.

April 25-26
SPI Midwest Plastics Conference, French Lick-Sheraton Hotel, French Lick, Ind.

June 11-15
SPI Seventh National Plastics Exposition & Technical Conference, Coliseum, New York, N. Y.

(Industrial News Briefs Cont'd. from page 184)

Acheson Dispersed Pigments Co. has moved from the plant site in Philadelphia, Pa., to the Morris Bldg., Philadelphia 2, Pa. The firm's purchasing and general office staffs will remain at the plant (2250 E. Ontario St.). The move was made to provide more processing space at the plant.

Monsanto Chemical Co., plastics division, Springfield, Mass., is consolidating and modifying its chemical melamine facilities at Everett, Mass., to permit further manufacturing efficiencies and increased production. The changes, which will not require any shut-downs, are expected to be completed by the end of May.

Verband Deutscher Schaumstoffverarbeiter, e.V., Wiesbaden, Germany, has been formed by processors of moltoprene-based foams. The new association will represent the interests of members in dealings with suppliers, buyers, the government, and other organizations of the industry. In addition, it will advise members on technical questions and keep them posted on developments in the market and in technology.

B. F. Goodrich Co., Marietta, O., has added a total of 36 new decorator colors to the five current patterns of Koroseal furniture upholstery materials.

Parkway Plastics, Inc., has opened a new plant and offices at Stelton Road, New Market, N. J. Correspondence should be directed to New Market P.O. Box 475.

A polystyrene factory is reportedly to be set up in India by a Bombay company under an arrangement with an American concern which, it is understood, will supply equipment for an initial output of 6,000,000 pounds of polystyrene annually.

Burlington Narrow Fabrics, New York, N. Y., a member firm of Burlington Industries, Inc., has expanded its range of products to include plastic webbing for summer furniture and other uses. This webbing, made of Firestone Plastic Co.'s Velon, is available in a complete range of standard and decorator colors, and is woven in the company's South Hill, Va., plant.

Carbide & Carbon Chemicals Co.'s textile fibers department, New York, N. Y., has announced a price reduction for Dynel acrylic fibers, retroactive to November 1, 1955. The new prices average approximately 16% less on a pound basis.

Continental Can Co.'s Millsplastic division has moved its sales offices, general administrative offices, and research department to 2930 North Ashland Ave., Chicago 3, Ill.

Rigid polystyrene foam, known in Germany as Styropor, is now being produced in Austria under the name of Porozell.

Owens-Corning Fiberglas Corp.'s textile products division has announced the transfer of its plastic technical sales service group and plastics products development group from Newark, O., to Ashton, R. I.

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